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Roentgen Diagnosis of Primary Atypical Pneumonia[1]

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OUR PURPOSE IN presenting this paper is to describe the roentgen manifestations of primary atypical pneumonia of unknown etiology (1–7) and to differentiate it from pulmonary lesions which it simulates. These include acute and chronic infections of bacterial, fungus, and virus etiology, occasionally tuberculosis, atelectasis, passive congestion, and neoplastic and metastatic infiltrations.

The term atypical pneumonia refers to virus diseases of either known etiology, such as influenza A or B and ornithosis (psittacosis), and those of unknown etiology. Roentgenologically these cannot be differentiated one from another, and for the purpose of this discussion they will be considered in the same category.

The material here presented is based on a correlation of the roentgenological, physical, and pathological findings.

PATHOLOGY

In order better to understand the various roentgen findings, a brief review of the pathology of atypical pneumonia seems necessary. As shown in the microscopic sections taken from our one case which terminated fatally, as well as in those submitted to us by the Army Medical Museum (8), the pathology is that of an interstitial pneumonitis. It corresponds to the descriptions of Longcope (9) and Saphir (10).

Grossly, the hilar lymph nodes are hyperplastic and edematous. The larger bronchi are inflamed. These pathological changes may explain the increased size and density of the hilar shadows seen in the roentgenogram. The walls of the smaller bronchi are thick and rigid and project above the lung surface when seen on cut section. This thickening and rigidity are represented in the roentgenogram by increased pulmonary markings. Although the lung for the most part is air-containing, focal areas of atelectasis or alveolar exudation are seen. These may explain the mottled density demonstrable roentgenographically in the lung parenchyma (Fig. 18).

Microscopically there is a profound infiltration of mononuclear cells, affecting chiefly the bronchial walls, peribronchial structures, and interalveolar septa, as illustrated by the photomicrographs from our case (Figs. 1–5).

Figure 1 shows thickening of the interalveolar septa by an infiltration consisting

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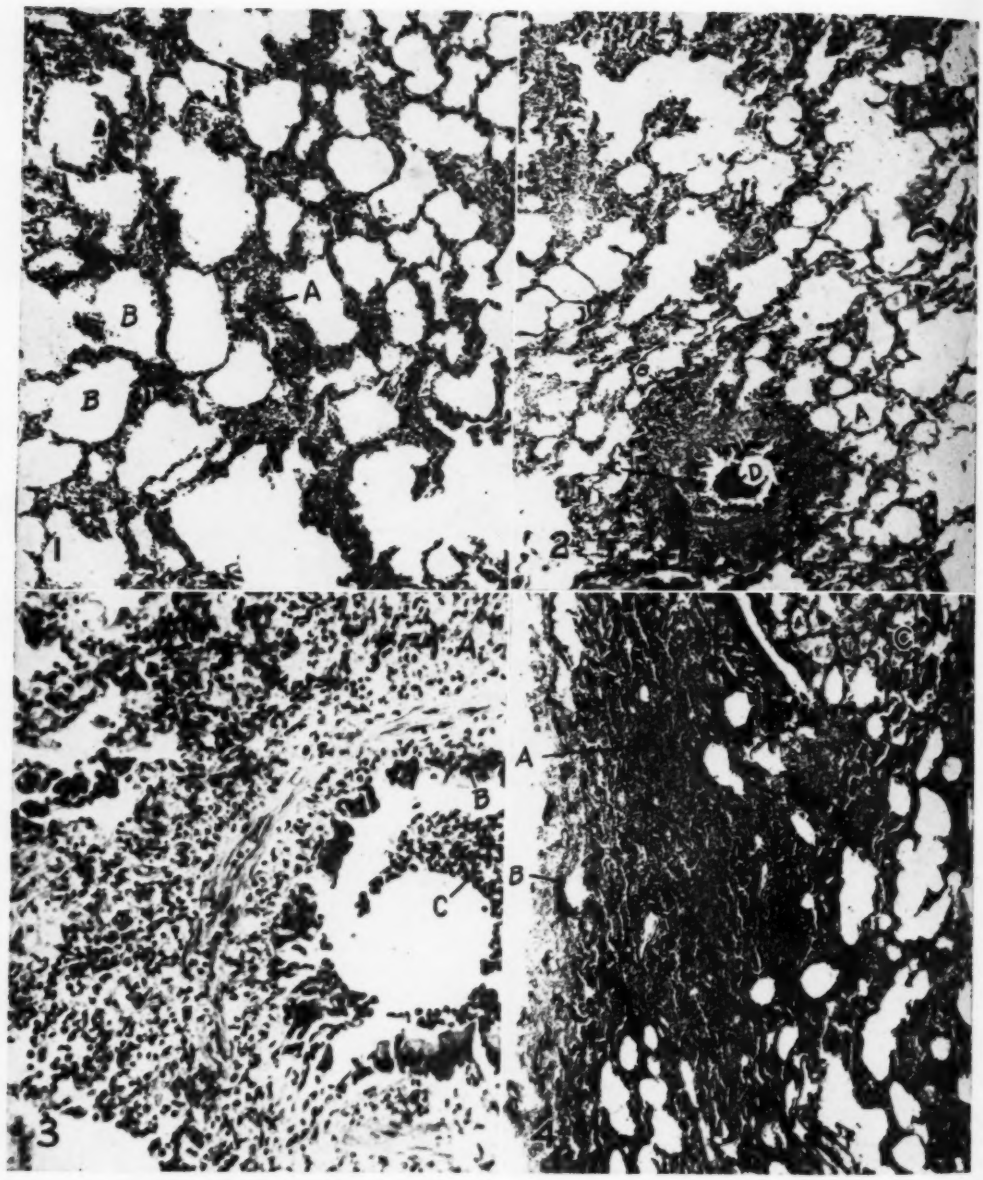

Fig. 1. Showing thickening of interalveolar septa by mononuclear elements and edema (A) and alveoli free of exudate (B), characteristic of interstitial pneumonitis. ×80.

Fig. 2. Showing thickening of the bronchial wall (A), peribronchial and septal infiltration (B), fragmentation of the mucosa (C), and cellular exudate (D). ×55.

Fig. 3. Showing bronchus under high magnification. Peribronchial infiltration with mononuclear elements (A), disruption of the mucosa (B), and large cellular plug (C). ×220.

Fig. 4. Showing atelectasis adjacent to bronchus (A), infiltration of visceral pleura (B), and alveolar exudation (C). ×40.

of lymphocytes, histiocytes containing blood pigment, and mononuclear cells (A). The alveoli are free of exudate (B). Because they are still air-containing, the shadow density presumably due to the interalveolar infiltration tends to be soft (Figs. 12–14).

Figure 2 shows a bronchus, the wall of which is edematous and is infiltrated by the same cellular elements (A) as in Figure 1. This infiltrate is present in the peribronchial and adjacent interalveolar septa (B). The bronchial mucosa is fragmented (C). Its epithelium is eroded and the cilia are absent. The lumen is filled by a fibrinous exudate consisting mostly of neutrophils, some histiocytes, and a few monocytes (D). This peribronchial inflammatory reaction as well as the associated congestion may explain the increased density of the truncal markings seen roentgenologically (Figs. 6, 8).

Figure 3 (high-power) shows in more detail the peribronchial infiltrate and atelectasis (A), the thickening of the bronchial walls, the disruption of the mucosa (B), and the cellular plug within the lumen (C).

Figure 4 shows an area of atelectasis adjacent to the bronchus (A). Such areas are fairly common and probably are the result of bronchial occlusion by the cellular exudate (Fig. 3). They may account for or contribute to the soft, downy shadows seen in the periphery of the lung or in the costophrenic angles (Figs. 15, 20). The visceral pleura also shows edema and infiltration (B), appearing on the roentgenogram as slight thickening of the pleura or occasionally a tenting of the diaphragm (Fig. 6). A small patch of alveoli containing a gelatinous exudate is shown (C). In this exudate is found an occasional monocyte but no neutrophils. It is the presence of this exudate that accounts for the patchy density (Fig. 18).

Figure 5 shows an interstitial pneumonitis (A) and a confluent bronchopneumonia containing pneumococci (B). In the latter, the alveoli are filled with an exudate characteristic of the bacterial pneumonias. Such areas of bronchopneumonia also show

Fig. 5. Interstitial pneumonitis (A) and bacterial pneumonia (B). ×55.

as a patchy density. Usually they are more dense and more lobular than are those seen in atypical pneumonia. When, however, there is alveolar exudation, irrespective of its nature, aids other than the x-ray are necessary to determine its kind (5, 7).

Lesions similar pathologically to those described above have been observed in influenzal pneumonia (11), ornithosis (psittacosis), American Q fever, and the pneumonias of measles and pertussis (8).

SOURCE OF MATERIAL

During the period December 1942 to May 1943, inclusive, about 6,000 patients with an acute epidemic respiratory tract infection were admitted to the Station Hospital, Fort Custer, Mich. Of 500 such patients who were studied in detail, approximately 25 per cent showed roentgen evidence of pulmonary involvement.

CRITERIA FOR DIAGNOSIS

It has been said by some that the x-ray findings of atypical pneumonia are char-

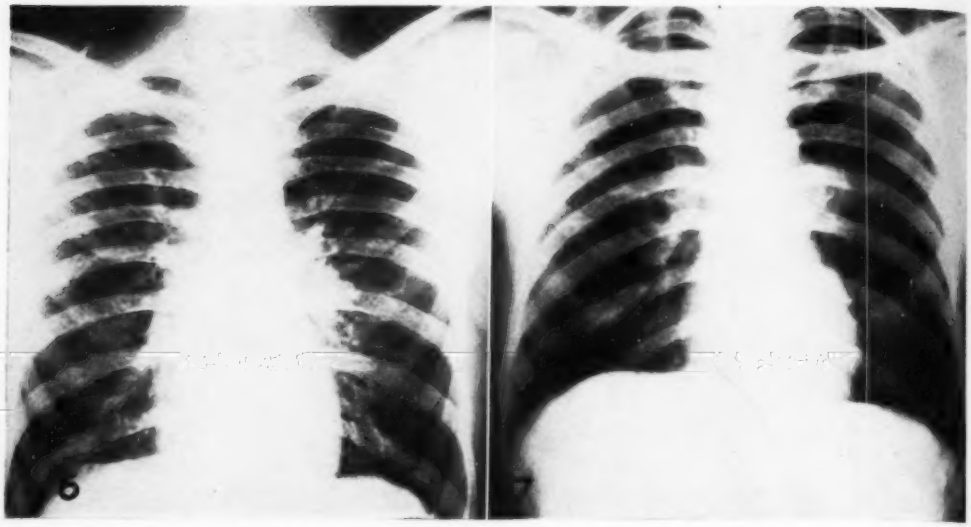

Fig. 6. Bronchitic phase, showing increase in size and density of hilar shadows, prominent pulmonary markings, and a pleural adhesion to the right dome of the diaphragm.
Fig. 7. Boeck's sarcoid, showing enlarged hilar nodes and soft infiltration into the right lung.

acteristic. This statement we feel is not warranted, without qualification. While roentgenologically atypical pneumonia has certain distinguishing features, a diagnosis based solely on the roentgenograms is impossible. Mindful of this, we have felt it necessary to establish certain criteria as a basis for diagnosis. These have reference to the mode of onset, clinical course, physical findings, roentgen findings, white blood count, bacteriologic examination of the sputum, and the response to the sulfonamides.

From our studies of the epidemic of acute respiratory tract infection, we are convinced that the pulmonary lesions are but a local manifestation of a syndrome in which both the upper and lower respiratory tract participate. Just as the disease may predominantly affect the nasopharynx, the larynx, or the trachea, and be correspondingly designated as a nasopharyngitis, laryngitis, or laryngo-tracheitis, so it may affect any part or parts of the pulmonary tract simultaneously or successively. From our physical and x-ray examinations, we find that the manifestations in the lung fall naturally into four phases, *viz.*, the bronchitic, peribronchitic, alveolar, and broncho-alveolar, depending upon what part of the pulmonary tract is predominantly involved.

ROENTGEN DESCRIPTION OF THE PHASES

Bronchitic Phase (Fig. 6.): The bronchitic phase is characterized by increased size and density of one or both hilar shadows (12) and prominence of the truncal shadows extending from the hila into the lower lobes. The markings of the smaller bronchi likewise may be demonstrated in the peripheral zone of the lung. These roentgen findings might be explained by the hyperplasia and congestion of the hilar lymph nodes and by the infiltration and congestion in the bronchial and peribronchial tissues (Figs. 2, 3).

The bronchitic phase must be differentiated from acute and chronic bronchitis, of whatever cause, as, for example, chronic sinusitis, tonsillitis, and inhalation of irritating gases. To be considered, also, are passive congestion and enlargement of the hilar nodes of whatever nature.

Certain lesions, as the various types of bronchitis, cannot be differentiated by x-ray studies alone; dependence must be

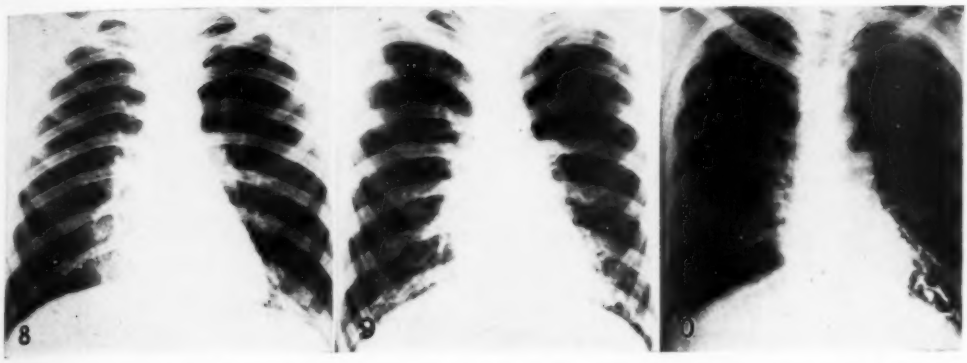

Fig. 8. Peribronchitic phase, showing increased truncal markings in both cardiophrenic areas and evidences of peribronchial infiltration in the left base.
Fig. 9. Bronchiectasis with peribronchial infiltration, simulating atypical pneumonia.
Fig. 10. Bronchiectasis: case shown in Fig. 9 after lipiodol instillation, demonstrating sacculations.

placed, also, on the history and laboratory findings. Some, however, have roentgenologic features which suggest their identity. Among these are passive congestion, lymphoblastomata, Boeck's sarcoid, and the pneumonias of tularemia and measles. In passive congestion the hilar shadows are increased, the pulmonary markings are heavy, occur bilaterally, and generally extend from the hila to the middle zone of the lung. The finding of cardiac disease serves as corroborative evidence. In lymphoblastomata and Boeck's sarcoid (Fig. 7), the hilar enlargement appears more rounded or lobulated. Serial roentgenograms show the enlargement progressing in size. As this occurs, parenchymal miliary infiltrations begin to make their appearance. In tularemia and measles pneumonia, though the hilar adenopathy is the first lesion present, it is soon followed by outspoken evidences of bronchopneumonia.

In other conditions causing hilar enlargement, as tuberculosis and neoplasms, serial roentgenograms whereby progression and regression are shown are of considerable service in differentiation.

Peribronchitic Phase (Fig. 8): The peribronchitic phase is characterized by an increase in prominence of the truncal markings as they extend from the hila downward into the cardiophrenic sinuses and lower lobes and outward into the lung parenchyma. Intimately associated with the increased bronchial and peribronchial shadows, irregular areas of varying opacity and soft mottling are seen. A probable explanation for these shadows may be the presence of peribronchial infiltration, as shown in Figures 2 and 3.

The peribronchitic phase (Fig. 8) is the one most likely to be confused with bronchiectasis, particularly that associated with peribronchial reaction (Fig. 9). The sites and the roentgenological appearances may be similar. While in some instances the presence of bronchiectasis may be suggested by the apparent stability, solidity, and persistence of the lesions as seen on serial roentgenograms, a positive diagnosis can be made only by a bronchogram (Fig. 10). This similarity on the plain roentgenogram may be seen by comparing illustrations of the peribronchitic phase (Fig. 8) and a case of bronchiectasis (Fig. 9).

Alveolar Phase (Figs. 11–16): In the alveolar phase, the lesion is variable with respect to location, size, shape, and density (14). It may be located anywhere in the lung, either adjacent to the hilum or out toward the periphery, but seldom does it reach the lung margin. It may occur along the bronchus dorsalis, as seen when roentgenograms are made in the lateral position (15). Usually, however, it is found extending from the hilum outward

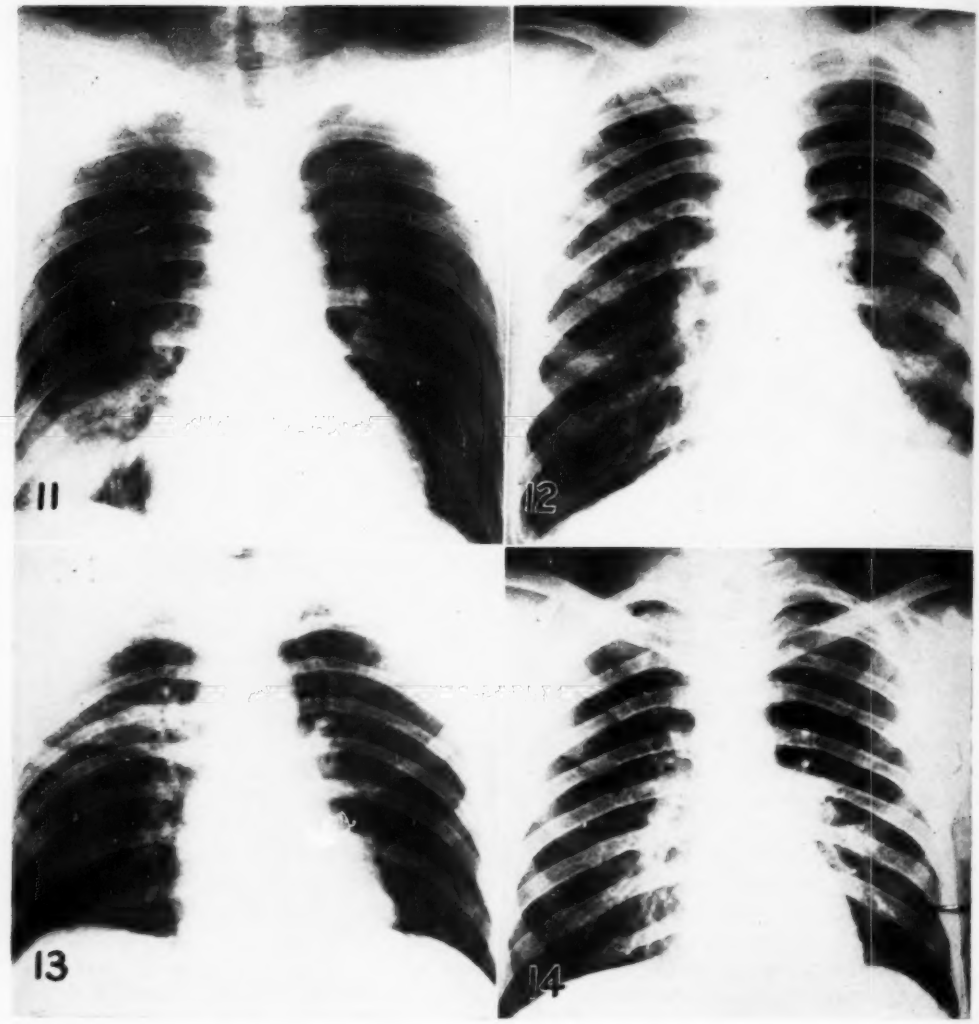

Fig. 11. Alveolar phase: soft, ill-defined, fan-shaped density extending downward from the right hilum.
Fig. 12. Aleveolar phase: soft, hazy, cloud-like densities in the lower left and upper right lobes.
Fig. 13. Alveolar phase: soft, fan-shaped density radiating upward from the right hilum, simulating tuberculosis.
Fig. 14. Alveolar phase: soft density in right second anterior interspace, peripherally, simulating tuberculosis.

and downward into the lower lobes (14). In about 20 per cent of the cases it is bilateral (6). The roentgen shadow varies from the size of a millet seed to involvement of the greater part of a lobe (Fig. 11). The smaller lesions are generally rounded, sometimes irregular, well defined or poorly defined, usually dense, and more commonly found in the lower lobes. The larger lesions are usually triangular, fan- or wedge-shaped, for the most part poorly defined but sometimes well outlined and isolated. Characteristic of all lesions is their soft density. The shadows take on a cloud-like, hazy, downy, ground-glass appearance, fading toward the periphery. Often they are fleeting, migratory, and bizarre. When the pulmonary mark-

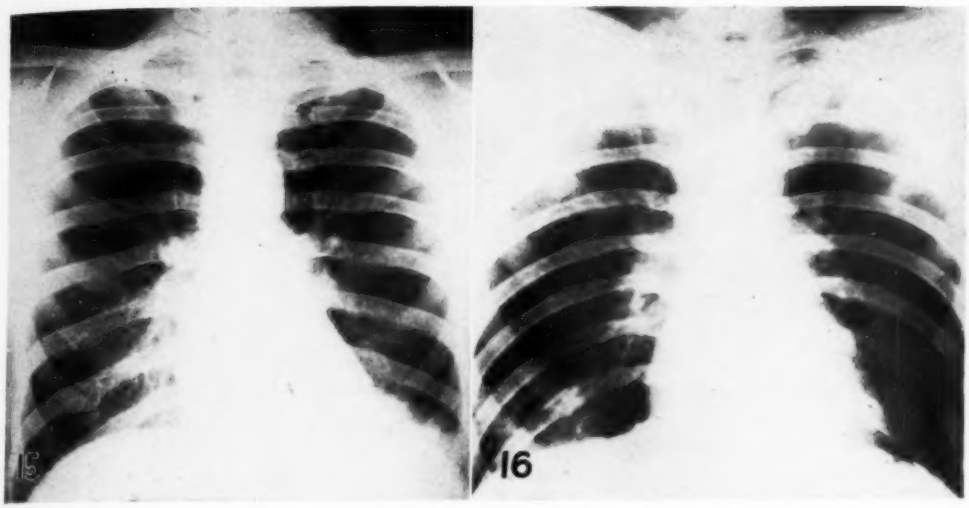

Fig. 15. Alveolar phase: shadow in left base simulating atelectasis.
Fig. 16. Alveolar phase: stage of resolution, resembling a lung abscess.

ings are heavy, they can be seen through this soft parenchymal density.

The roentgen findings described above could be explained pathologically by large areas of atelectasis or alveolar exudation (Fig. 4) or by fairly extensive, heavy but localized areas of interstitial inflammation. It is this picture, distinctive of the alveolar phase, that so often appears unannounced or unaccompanied by symptoms or physical findings, to be disclosed only by chance or on routine roentgen examination. It is to the alveolar phase that reference is made when so often atypical pneumonia is referred to as "x-ray pneumonia."

Because of the extreme variability of its shadows, the alveolar phase must be differentiated from many other pulmonary lesions. These include bacterial pneumonias, especially the lobar type, tuberculosis, atelectasis, pulmonary abscess, encapsulated fluid, neoplasms, and rickettsial and fungus infections. In lesions of the last two types, the differentiation cannot be made roentgenologically, but depends on other aids.

In lobar pneumonia, the shadow is more homogeneous and opaque, usually involves the entire lobe, and frequently is accompanied by evidence of pleuritis. Partial consolidation or partial resolution of the bacterial lobar pneumonias simulates atypical pneumonia to a marked degree. Differentiation is facilitated by a knowlege of the age of the process.

The exudative form of tuberculosis, appearing as a fan-shaped shadow radiating from the hilum or a solitary parenchymal lesion, must be differentiated from atypical pneumonia. Figures 13 and 14 show the similarity of the alveolar phase to tuberculosis. Roentgen differentiation depends entirely upon serial roentgenograms, as a fleeting, migratory lesion is not characteristic of tuberculosis.

Small areas of atelectasis may be simulated by atypical pneumonia. While these cannot be differentiated except by the history and physical examination, the presence of a horizontal linear disk type of shadow and elevation of the diaphragm on the affected side are suggestive of atelectasis. Figure 15 shows a lesion in the left base which, upon physical examination, was considered an area of atelectasis.

Lung abscess without a fluid level may be simulated by a clearing atypical pneumonia (Fig. 16). Serial x-ray studies show the latter to regress rather rapidly, without a distinct peripheral zone of reaction and

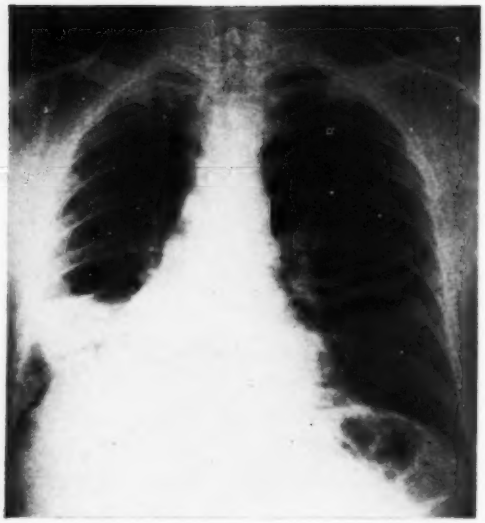

Fig. 17. Atelectasis associated with bronchial neoplasm, simulating atypical pneumonia.

without scarring. In contradistinction, an abscess cavity usually is sharply demarcated, has a dense peripheral zone of reaction, disappears slowly, and often leaves evidence of scarring.

Encapsulated fluid may sometimes be simulated by atypical pneumonia when the latter occurs adjacent to the interlobar fissures. Differentiation can be made by roentgenograms taken in the lateral position. A convex, sharply demarcated, fusiform or wedge-shaped shadow is characteristic of encapsulated fluid. Encapsulated fluid in locations other than the interlobar fissures is differentiated by a well defined, dense, homogeneous shadow.

Neoplasms are seldom confused with atypical pneumonia unless there be a zone of reaction around the lesions, making them irregular and feathery in outline. Where an associated pulmonary atelectasis is a prominent feature, differentiation is difficult (Fig. 17). On serial roentgenograms, these lesions are stable, tend to enlarge, and do not regress.

Broncho-Alveolar Phase (Fig. 18): The broncho-alveolar phase is characterized by irregular, soft, patchy, mottled areas of increased density in the lung parenchyma. These parenchymal densities may exist as small patches or, occasionally, as coarse mottlings in the direction of the pulmonary markings. If the coarse mottlings be widespread, a diffuse type, the so-called "disseminated focal pneumonia" of Scadding (6, 13) is present. The roentgen manifestations of the broncho-alveolar

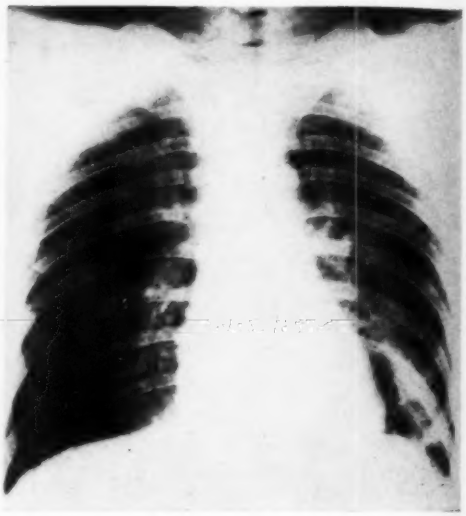

Fig. 18. Broncho-alveolar phase: diffuse mottling in lower left and upper right lobes and right cardiophrenic area.

phase could be explained pathologically by the small areas of atelectasis and alveolar exudation intermingled with emphysematous areas.

In the broncho-alveolar phase, as in the peribronchitic, which likewise shows dense truncal and hilar markings, the x-ray findings may persist long after the patient is clinically well, in some instances as long as five months.

The broncho-alveolar phase must be differentiated from a variety of conditions, such as bacterial bronchopneumonia, tuberculous bronchopneumonia, the rickettsial and fungus infections, tularemia and measles pneumonias, and occasionally infected bronchiectasis. For the most part, it is difficult if not impossible to make the differentiation on roentgenologic findings alone.

Tuberculous bronchopneumonia (Fig. 19) may simulate this phase of atypical pneumonia so exactly that only serial roentgenograms can be of service. In tuberculous pneumonia, the lesions tend to progress and to become confluent, whereas in atypical pneumonia regression is the rule. Tularemia and measles pneumonias may also simulate this phase of the

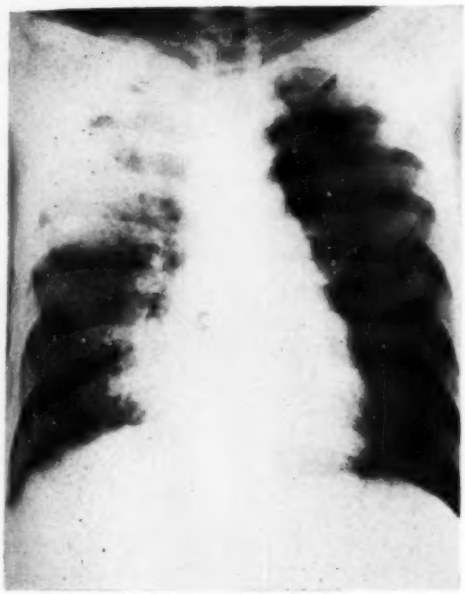

Fig. 19. Tuberculous bronchopneumonia, with tubercle bacilli in sputa, simulating the broncho-alveolar phase.

disease (Fig. 20). These lesions generally are widespread, more dense and sharply demarcated than those of atypical pneumonia. Helpful in differentiation is the tendency for the hilar shadows in tularemia and measles to be larger, denser, and more lobulated. Bronchiectasis with its zone of reaction due to parenchymal infection must be taken into consideration. Its positive differentiation, as has been shown, can be accomplished only by the bronchogram (Fig. 10).

COMPLICATIONS

The infrequent occurrence of complications of atypical pneumonia has been considered by others (16, 17). Occasionally

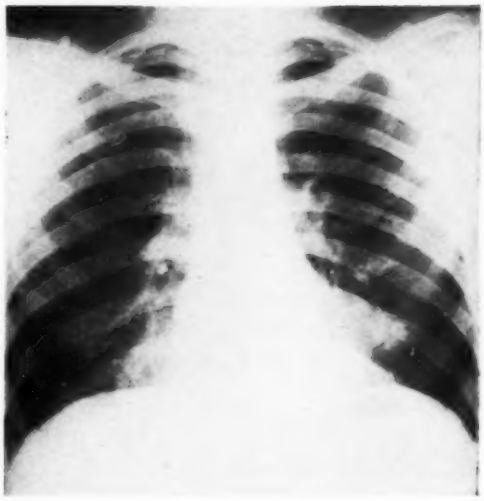

Fig. 20. Measles bronchopneumonia, simulating the broncho-alveolar phase of atypical pneumonia. Soft densities are seen in both cardiophrenic angles and the right costophrenic angle.

we have observed a pleurisy, transitory or adhesive in type, and rarely effusive. The latter, we feel, is usually due to a secondary invader, in which case an empyema may result. Elevation of the diaphragm indicative of pleurisy is often the precursor of pneumonia (18). This pneumonia may be suspected of being bacterial in origin when there is a coalescence of the lesions and the shadow densities become increased.

SUMMARY AND CONCLUSION

In an epidemic of some 6,000 cases of acute respiratory tract infection, about 25 per cent showed some phase of atypical pneumonia. The roentgenologic aspects of the disease, which presumably is of virus origin, are presented. It was found that atypical pneumonia might conveniently be divided into four phases, *viz.*, the bronchitic, peribronchitic, alveolar, and broncho-alveolar. Each of these four phases, after correlation with the pathology, has been compared with and differentiated from lesions with which it is most likely to be confounded. It is shown that the x-ray findings in themselves are insufficient evidence upon which to base a

diagnosis and that such aids as physical and laboratory findings must be mustered into service.

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A Comparative Roentgen Study of Primary Atypical and Bacterial Pneumonia[1]

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NUMEROUS articles have appeared in the literature concerning the bacteriologic and clinical aspects of primary atypical pneumonia, and sporadic attempts have been made to establish roentgenologic criteria for its differentiation from bacterial pneumonia. As Rigler (1) put it, "in the case of acute lung conditions the roentgenogram presents an *autopsia in vivo*, requiring only adequate and intelligent interpretation to make it the most valuable adjunct in the diagnosis and study of pneumonia."

Bowen (2), in 1935, was one of the first to describe the clinical syndrome now designated as "primary atypical pneumonia," which he called "acute influenza pneumonitis." His description of the characteristic roentgen appearances of this syndrome has remained fairly constant throughout the literature. The roentgen shadow is usually described as extending outward from the hilum well into the parenchyma, occasionally reaching the periphery, presenting the appearance of a confluent mottled fan-shaped or rounded area, usually of homogeneous density in the central portion, with the borders fading into the normal lung.

In 1940, Kornblum and Reimann (3) called attention to the "great variability in the type of lesion produced." One of the characteristic lesions they describe as "a fairly well localized area of increased density situated in various portions of the lung but occurring predominantly in the lower lobes. The areas while variable in size were never very large, thus differing from the consolidations encountered in lobar pneumonia. Although the inflammatory reaction was localized, it was not sharply defined, the opacity tending to merge imperceptibly with the surrounding pulmonary tissues. The areas of involvement varied considerably in density. Again, they were never as dense as the consolidations of lobar pneumonia."

Dingle and Finland (4) suggested similar characteristic findings for the roentgen diagnosis of primary atypical pneumonia, including an increase in size of one or both hilar shadows, followed by an infiltration, extending outward from the hilum toward the periphery of the lung fields, often in the shape of a fan or wedge, fading out gradually into the normal lung parenchyma. The density was described as usually soft, either mottled or homogeneous, more dense near the hilum, but rarely so dense and circumscribed as that in pneumococcal pneumonia and seldom occupying more than a portion of the lobe.

In January 1943, Seeds and Mazer (5), on the basis of 221 cases, established criteria for the roentgen diagnosis of primary atypical pneumonia, which they considered characteristic and fairly constant for the syndrome. They employed such phrases as "cotton-wool appearance of multiple areas of partial or semiconsolidation;" "radial progression;" "occasionally . . . filling approximately a whole lobe to simulate lobar pneumonia but, so far as we have seen, always managing to present a striated infiltrative type background rather than a pure homogenicity;" "development of an appearance of 'wire-grass' infiltration or 'pseudofibrosis'."

In an exhaustive study of primary atypical pneumonia at an army camp, Dingle *et al.* (6) also found the roentgen appearances of the lesions to be "rather characteristic." Their description included an increase in size of the hilar shadow, unilaterally or bilaterally, extending toward the periphery of the pulmonary field in a

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wedge or fan shape, usually fading into the normal parenchyma of the lung before the periphery was reached. They found that one or the other cardiophrenic angle was a common site for the lesion. The infiltration is described as soft and either patchy or homogeneous in character, rarely of sufficient density to resemble a pneumococcic pneumonia.

During the course of twelve months, from August 1942 through July 1943, 2,062 cases of pneumonia were seen at the Regional Station Hospital in Sioux Falls, S. D.; 950 were bacterial pneumonias and 1,112 were primary atypical pneumonias. From a review of these cases, we have come to the conclusion that any attempt to determine the probable etiology of a case of pneumonia from the roentgenogram *alone* is an extremely inaccurate procedure. Cases of primary atypical pneumonia may present a roentgen appearance indistinguishable from that of pneumococcic or other bacterial pneumonias, especially the early and/or resolving stages of the latter. Contrary to most of the descriptions in the literature, we have seen many cases of atypical pneumonia which did not originate in the hilar regions and extend outward, but occurred as circumscribed foci in the periphery of the lung field. We have also seen primary atypical pneumonias occurring in the upper lobes, with roentgen findings simulating those of tuberculosis, as mentioned by Moore and his associates (7).

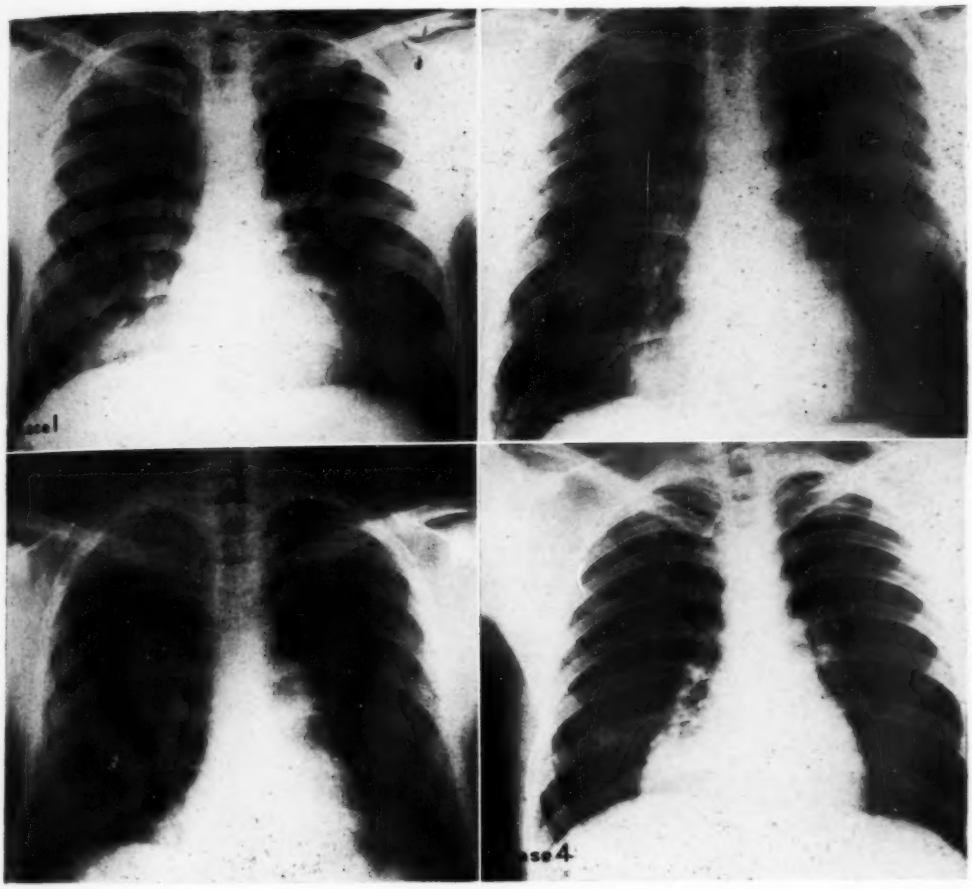
From the vast amount of clinical material available, we have selected 19 cases which demonstrate the variations of roentgen shadows in both bacterial and primary atypical pneumonia. Careful attention was paid to the clinical symptomatology and laboratory findings in each case. *Only* those cases of pneumococcic pneumonia in which a definite pneumococcus of known virulence was isolated from the sputum were included in this study. The cases selected from the primary atypical pneumonia group conformed to clinical criteria described in previous publications, with a consideration of such factors as a gradual onset of symptoms, absence of pleural pain, presence of organisms in the sputum, a relatively low blood count, and absence of other complications. Any case which did not conform rigidly to these criteria was *excluded* from the study.

CASE PRESENTATIONS

CASE 1: Pvt. M. G. L., aged 19, was admitted to the station hospital on May 6, 1943, with a dry hacking cough, fever, and chilly sensations. Suppressed breath sounds and fine crepitant râles were heard over the right lower lobe posteriorly. The temperature was 100.4° F., pulse 80, and respirations 24 per minute. The white blood count was 5,850, with 70 per cent polymorphonuclear leukocytes. No pneumococci were found in the sputum. Roentgen study of the chest revealed a fairly homogeneous increased density in the right cardiophrenic angle consistent with a pneumonia. A diagnosis of primary atypical pneumonia was made. Following a rise to 102° F. several hours after admission, the temperature fell to normal by lysis in seven days. A roentgenogram taken nine days after admission showed some extension into the right middle and right lower lobes. At this time the patient was afebrile and clinically well. Subsequent roentgen studies showed progressive resolution of the lesion.

CASE 2: Pvt. H. C. C., aged 36, was admitted to the station hospital on April 24, 1943, with a dry hacking cough of three days' duration, a sore throat, malaise, and nasal congestion. Clusters of fine crepitant râles were heard at the right base. The temperature was 102.2° F., pulse 110, and respirations 24 per minute. The white blood count was 10,800, with 76 per cent polymorphonuclear leukocytes. No pneumococci were found in the sputum. Roentgen study of the chest revealed an increased density in the right cardiophrenic angle consistent with a pneumonia. A diagnosis of primary atypical pneumonia was made. The temperature gradually dropped to normal in four days with no specific therapy. A roentgenogram taken on May 7, 1943, showed complete resolution of the pneumonia.

CASE 3: Pvt. R. C. W., aged 18, was admitted to the station hospital on May 2, 1943, with a severe hacking cough and sharp pain in the right chest, shaking chills, and fever. On physical examination dullness was elicited over the lower half of the right chest, with suppressed breath sounds and many crepitant râles. The temperature was 102.6° F., pulse 112, and respirations 24 per minute. The white blood count was 19,200, with 88 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed an increased density in the right cardiophrenic angle. A diagnosis of bacterial pneumonia, type II, was made. The patient made an uneventful recovery on sulfadiazine therapy.



Figs. 1–4. Cases 1 and 2. Primary atypical pneumonia. Cases 3 and 4. Pneumococcic pneumonia.

CASE 4: Pvt. P. L. S., aged 22, was admitted to the station hospital on Feb. 12, 1943, complaining of sudden shaking chills, fever, and pain in the right upper chest. A dry hacking cough had persisted for several days previously. Soon after the onset of the chills and fever, the patient had expectorated some blood-streaked sputum. Dullness and fine moist râles were heard at the right base. The temperature was 102.6° F., pulse 98, and respirations 24 per minute. A pneumococcus, type VII, was recovered from the sputum. The white blood count was 22,100, with 91 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a homogeneous increased density in the right cardiophrenic angle. A diagnosis of bacterial pneumonia, type VII, was made. This patient made an uneventful recovery on sulfadiazine therapy.

The pneumonic processes in the four cases just described were confined to the right cardiophrenic angle (Figs. 1–4). The first and second cases were primary atypical pneumonias, while the third and fourth were pneumococcic pneumonias. A careful roentgenologic appraisal of these four cases reveals no distinguishing features in the location, density, or structural pattern of the lesions which would aid the observer in differentiating the two primary atypical pneumonias from the two pneumococcic pneumonias.

CASE 5: Pvt. P. A. Z., aged 22, was admitted to the station hospital on April 27, 1943, with a wracking cough, chills, fever, and a sharp pain in the left portion of the chest. Dullness, suppressed breath sounds, and fine moist râles were heard over the left lower lobe area. The temperature was 103.2° F.,

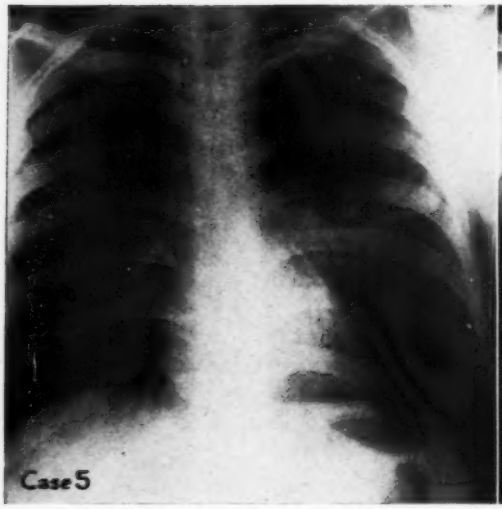


Fig. 5. Pneumococcic pneumonia.

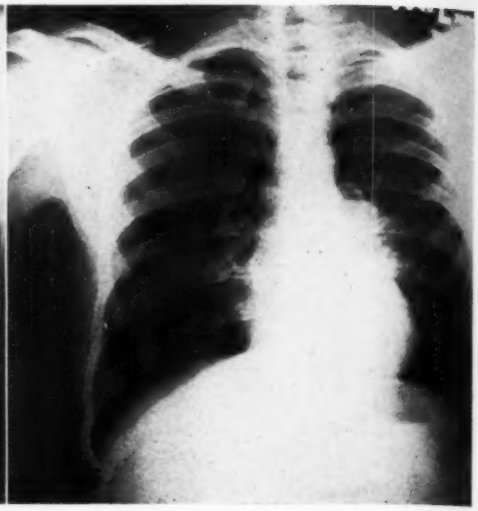


Fig. 6. Primary atypical pneumonia.

pulse 100, and respirations 36 per minute. The white blood count was 21,950, with 94 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a mottled increased density in the left hilum which extended out into the parenchyma in a fan-shaped manner. A diagnosis of bacterial pneumonia, type II, was made, sulfadiazine therapy was instituted, and an uneventful recovery followed.

CASE 6: Pvt. J. S., aged 19, was admitted to the station hospital on May 6, 1943, with a sore throat, hacking cough, nasal congestion, fever, and generalized aches and pains. Physical examination of the chest was entirely negative. The temperature was 101° F., pulse 100, and respirations 28 per minute. The white blood count was 8,300, with 65 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a fairly compact homogeneous density in the left hilum, consistent with a pneumonia. No pneumococci were found in the sputum. A diagnosis of primary atypical pneumonia was made. Follow-up roentgen study on May 19, 1943, showed a complete resolution of the pneumonia.

Shadows which originate in the hilum and extend into the periphery in a wedge-like or fan-shaped outline have been considered the "classical" roentgen picture of primary atypical pneumonia (2, 4, 6). This has not been our experience. Bacterial pneumonias frequently fan out from the hilum in a similar manner. Roentgen study of Case 5, a type II pneumococcic pneumonia (Fig. 5), revealed a mottled density radiating outward from the left hilum. Interpretation of this film without a knowledge of the clinical history would lead to an erroneous diagnosis of primary atypical pneumonia. Case 6, a primary atypical pneumonia in the left hilum, is presented for contrast. The roentgenogram of this case (Fig. 6) reveals a fairly homogeneous density localized to the left hilum, with slight fanning out into the periphery. A comparison of the two cases shows that the primary atypical pneumonia has a denser shadow than the bacterial pneumonia, and the bacterial pneumonia fans out, while the primary atypical pneumonia is more localized.

CASE 7: Pvt. R. M. G., aged 21, was admitted to the station hospital on April 14, 1943, with shaking chills, fever, nausea, vomiting, and a sharp pain in the left chest. Physical examination revealed dullness, diminished breath sounds, and some fine moist râles over the left lower lobe. The temperature was 101.2° F., pulse 112, and respirations 24 per minute. The white blood count was 15,400, with 84 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a spherical, fairly homogeneous increased density in the left lower lobe partially obscured by the cardiac shadow. A diagnosis of pneumococcic pneumonia, type II, was made. Recovery on sulfadiazine therapy was uneventful.

Roentgen study of this case (Fig. 7)

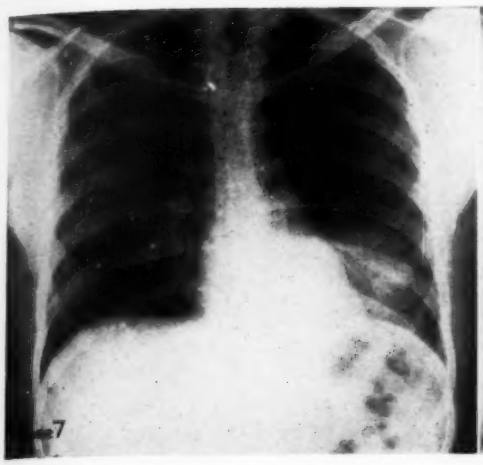


Fig. 7. Pneumococcic pneumonia.

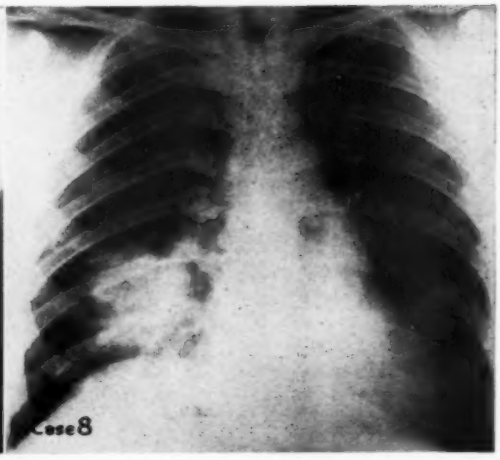


Fig. 8. Primary atypical pneumonia.

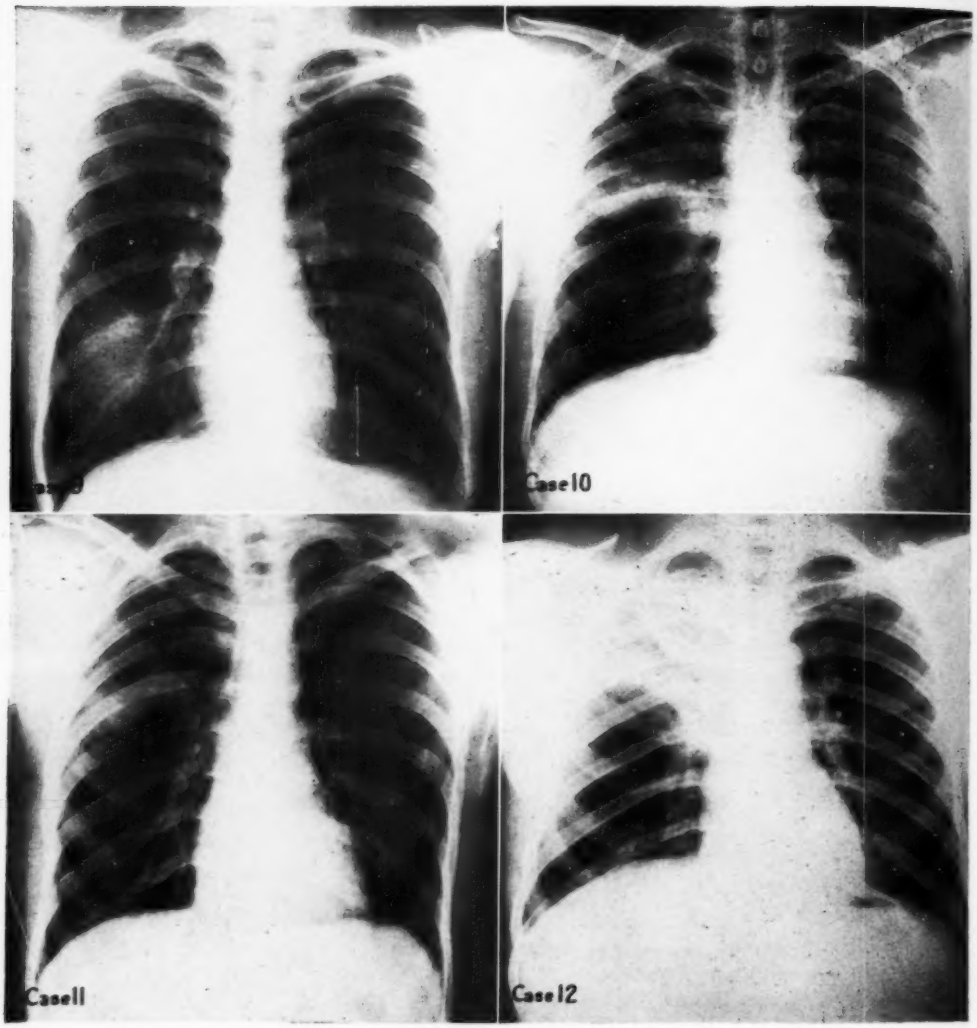
showed a homogeneous, spherical density in the left lower lobe, partially obscured by the cardiac shadow. The periphery of the lesion has a feathered appearance and merges imperceptibly with the surrounding pulmonary parenchyma. These roentgen characteristics would suggest primary atypical pneumonia, but the clinical picture is definitely that of a pneumococcic pneumonia, type II.

CASE 8: Pvt. G. F. G., aged 29, was admitted to the station hospital on March 7, 1943, with a history of a persistent hacking cough for one month, malaise and generalized aches and pains for several days. Many coarse, moist râles and bronchovesicular breath sounds were heard over the left lower lobe. The temperature was 103.8° F., pulse 100, and respirations 20 per minute. The white blood count was 11,400. No pneumococci were recovered from the sputum. Roentgen study of the chest revealed a fairly homogeneous spherical area of increased density in the region of the right cardiophrenic angle consistent with a pneumonia. The temperature fell to normal by lysis in three days, and the patient made an uneventful recovery. Three doses of sulfadiazine were administered during the first twenty-four hours of hospitalization, but the drug was discontinued as soon as a diagnosis of primary atypical pneumonia was made.

Some observers contend that primary atypical pneumonia does not produce a roentgen shadow as densely homogeneous as that of a bacterial pneumonia, but shows, usually, a striated type of lesion. This case (Fig. 8) is one of primary atypical pneumonia with a dense and fairly homogeneous spherical area of consolidation in the right cardiophrenic angle, which could easily be confused with that of a pneumococcic pneumonia.

CASE 9: Pvt. B. T., aged 32, was admitted to the station hospital on Dec. 23, 1942, complaining of a hacking cough and headache for three days and fever on the day of admission. Some crepitant râles were audible at the right base. The temperature was 102.8° F., pulse 90, and respirations 20 per minute. The white blood count was 10,300. No pneumococci were found in the sputum. Roentgen study of the chest revealed an oval, homogeneous area of increased density in the region of the right lower lobe. A diagnosis of primary atypical pneumonia was made. The patient's temperature fell to normal in four days and recovery was uneventful, with no specific therapy.

Roentgen study of this case (Fig. 9) reveals an oval area of density which might be confused with a pulmonary neoplasm, a lung abscess, or a parasitic cyst. The clinical course and subsequent complete resolution of the lesion established the diagnosis of primary atypical pneumonia. In our experience here, primary atypical pneumonias cast extremely bizarre roentgen shadows with such frequency that any attempt to establish definite or constant roentgen characteristics for this syndrome will lead to a high percentage of diagnostic error.



Figs. 9–12. Cases 9 and 12. Primary atypical pneumonia. Cases 10 and 11. Pneumococcic pneumonia.

CASE 10: Pvt. C. C. S., aged 38, was admitted to the station hospital on Feb. 18, 1943, with a hacking cough of several days' duration, sudden pain in the right chest, a shaking chill, and the expectoration of some rusty sputum. On physical examination bronchial breathing and post-tussic râles were heard over the upper half of the right chest anteriorly. The temperature was 103.6° F., pulse 110, and respirations 24 per minute. The white blood, count was 19,200, with 91 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a mottled increased density in the right hilum with extension into the lower portion of the right upper lobe, consistent with a pneumonia. The patient made an uneventful recovery on sulfadiazine therapy.

CASE 11: Sgt. J. D. S., aged 23, was admitted to the station hospital on Jan. 20, 1943, complaining of sharp pain in the right chest and a shaking chill which lasted for one hour the night before admission. A dry hacking cough preceded the acute onset by three weeks. Frank bronchial breath sounds were heard in the right axilla and lower anterior portion of the chest. The temperature was 104° F., pulse 120, and respirations 24 per minute. The white blood count was 17,800, with 87 per cent polymorphonuclear leukocytes. A pneumococcus, type VII, was re-

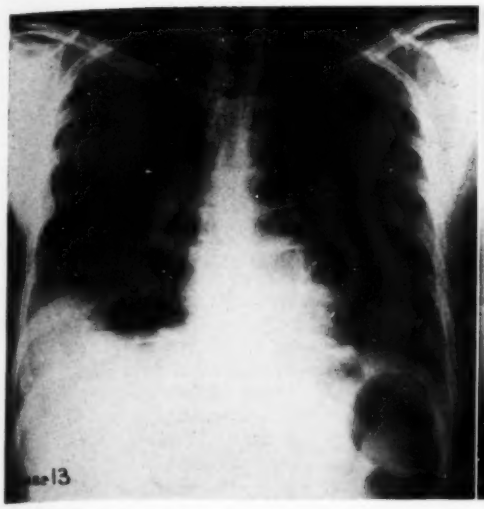


Fig. 13. Pneumococcic pneumonia.

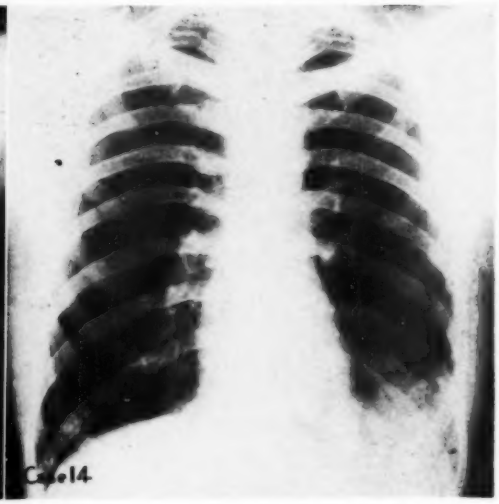


Fig. 14. Primary atypical pneumonia.

covered from the sputum. Roentgen study of the chest revealed an increased mottled density in the lower portion of the right upper lobe, apparently radiating from the right hilum, consistent with a pneumonia. The patient made an uneventful recovery on sulfadiazine therapy.

CASE 12: Pvt. R. P. T., aged 21, was admitted to the station hospital on Sept. 8, 1942, with a wracking cough of two weeks' duration, sore throat and hoarseness, malaise, and fever. Physical examination revealed a slight impairment of resonance at the right base but no definite signs of pneumonic consolidation. The temperature was 102° F., pulse 100, and respirations 20 per minute. Roentgen study of the chest on Sept. 17, 1942, showed an increased mottled density in the right upper lobe with a curved atelectatic lower border, suggestive of a tuberculous infiltration. The white blood count was 13,350, with 75 per cent polymorphonuclear leukocytes. Several sputum examinations proved negative for acid-fast organisms. In nine days the pneumonic lesion had resolved completely. A diagnosis of primary atypical pneumonia was made.

The pneumonias in the three cases just described were all in the right upper lobe. Case 10 was a pneumococcic pneumonia, type II, and Case 11 was a pneumococcic pneumonia, type VII. The clinical histories, bacteriologic findings, and response to sulfonamide therapy in both cases left no doubt of their pneumococcic etiology. On roentgen study (Figs. 10 and 11), however, both pneumonias seemed to originate from the hilar region and spread in a fan-shaped fashion into the right upper lobe. From the x-ray appearances *alone*, therefore, a diagnosis of primary atypical pneumonia would be justified; yet such a diagnosis would have been grossly inaccurate.

Case 12 is a primary atypical pneumonia of the right upper lobe (Fig. 12). The roentgen shadow here has the appearance of tuberculosis. Particularly noteworthy in this case is the curved, atelectatic lower margin of the lesion, so frequently seen in tuberculous infiltrations. A diagnosis of tuberculosis in this case was excluded only after the lesion had undergone complete resolution and repeated examinations of the sputa proved negative for tubercle bacilli.

CASE 13: Pvt. G. R. B., aged 22, was admitted to the station hospital on May 2, 1943, with sharp pain in the right chest which became aggravated by coughing or deep breathing, accompanied by chills and fever, with some bloody sputum. Dullness, bronchovesicular breath sounds, and fine crepitant râles were elicited over the right lower lobe area. The temperature was 103.6° F., pulse 92, and respirations 20 per minute. The white blood count was 29,800, with 88 per cent polymorphonuclear leukocytes. A pneumococcus, type V, was recovered from the sputum. Roentgenograms of the chest showed a homogeneous increased density, with indistinct peripheral edges, in the right lower lobe. The diagnosis was pneumococcic pneumonia, type V. The

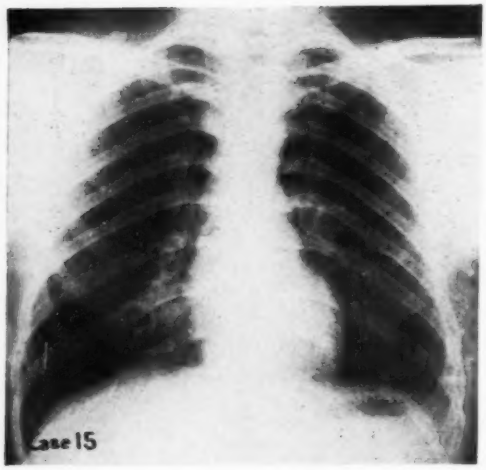


Fig. 15. Pneumococcic pneumonia.

patient made an uneventful recovery with sulfadiazine therapy.

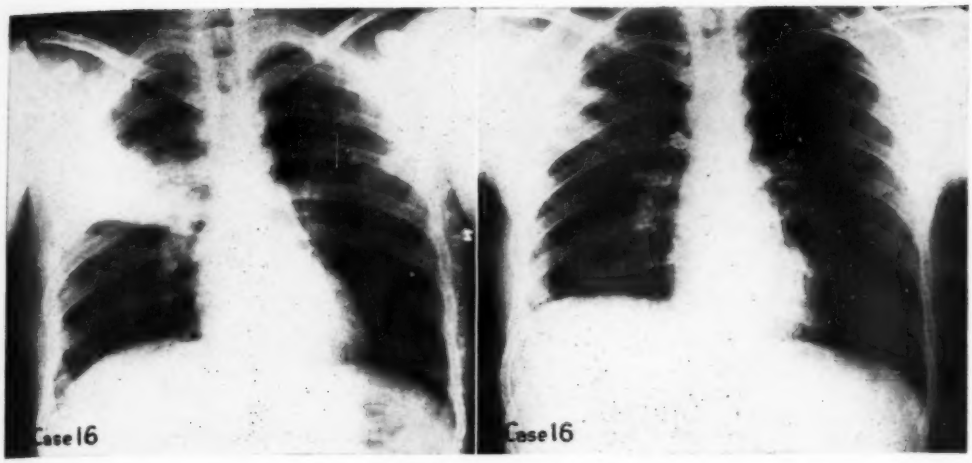
CASE 14: Pvt. C. C. H., aged 32, was admitted to the station hospital on April 14, 1943, complaining of a wracking cough productive of a moderate amount of mucoid sputum for three months, with generalized aches and pains and some chilly sensations setting in three days prior to admission. There were crepitant râles at both bases, more marked at the left base. The temperature was 100.4° F., pulse 100, and respirations 24 per minute. The white blood count was 9,900, with 77 per cent polymorphonuclear leukocytes. Roentgen study of the chest revealed a mottled increased density in the left lower lobe consistent with a pneumonia. A smaller but similar density was seen in the right lower lobe. A diagnosis of primary atypical pneumonia was made.

Case 13 is a pneumococcic pneumonia, type V, located in the right lower lobe. Case 14 is a primary atypical pneumonia with involvement of the left lower lobe. Roentgenographically (Figs. 13 and 14) the two lesions are very similar; etiologically, they are different.

CASE 15: Sgt. L. H. B., aged 21, was admitted to the station hospital on March 24, 1943, with a slight cough, present for two days, pain in the right chest, fever, vomiting, and expectoration of bloody sputum several hours before admission. Dullness and diminished breath sounds were elicited over the right lower lobe area and a few coarse râles were heard at the left base. The patient's temperature was 104.6° F., pulse 112, and respirations 38 per minute. The white blood count was 35,000, with 92 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest revealed a small mottled increased density in the region of the right cardiophrenic angle which could not be definitely interpreted as a pneumonia. The patient was given sulfadiazine therapy and progressed satisfactorily. Further roentgen study, March 28, 1943, showed the small mottled area to have increased in size, density, and distribution, so that the pneumonia was apparent. At the time of the second roentgenogram the patient's temperature was normal and he was convalescent from the acute infection.

CASE 16: Pvt. R. T. C., aged 21, was admitted to the station hospital on April 11, 1943, with severe chilly sensations, pain in the right chest, and expectoration of some bloody sputum. Signs of frank consolidation were elicited over the right interscapular area posteriorly. The temperature was 104.2° F., pulse 103, and respirations 30 per minute. The white blood count was 19,700. A pneumococcus, type VII, was recovered from the sputum. Roentgen study of the chest showed a dense consolidation in the lower half of the right upper lobe. A diagnosis of bacterial pneumonia, type VII, was made. The patient had an uneventful recovery with sulfadiazine therapy. A roentgenogram, taken on April 22, 1943, during convalescence, showed a resolving lobar pneumonia with a shadow indistinguishable from that of a primary atypical pneumonia (a linear increased mottled density radiating from the right hilum into the periphery).

One of the most important factors in the evaluation of the roentgenogram in cases of pneumonia is the stage of the pneumonia at the time of the roentgen examination. Most pneumonia patients admitted to the station hospital here were in a very early phase of the illness. Hence most of the roentgen films portrayed the incipient changes in the lungs, before the stage of maximum consolidation was reached. Case 15 is a pneumococcic pneumonia, type II. The admission film in this case (Fig. 15) shows a mottled density in the right cardiophrenic angle area. If the roentgenologist were to venture a diagnosis on the basis of this one film, he would undoubtedly designate the condition as a primary atypical pneumonia. At the time this roentgenogram was made, however, the patient had a temperature of 104.6° F., he was experiencing pleuritic pain, expectorated bloody sputum, and was extremely toxic. Four days later a repeat roentgen examination revealed a definite homogeneous area of consolida-



Figs. 16 and 17. Pneumococcic pneumonia. The left-hand film was made at the height of the disease; the other eleven days later, when resolution was well under way.

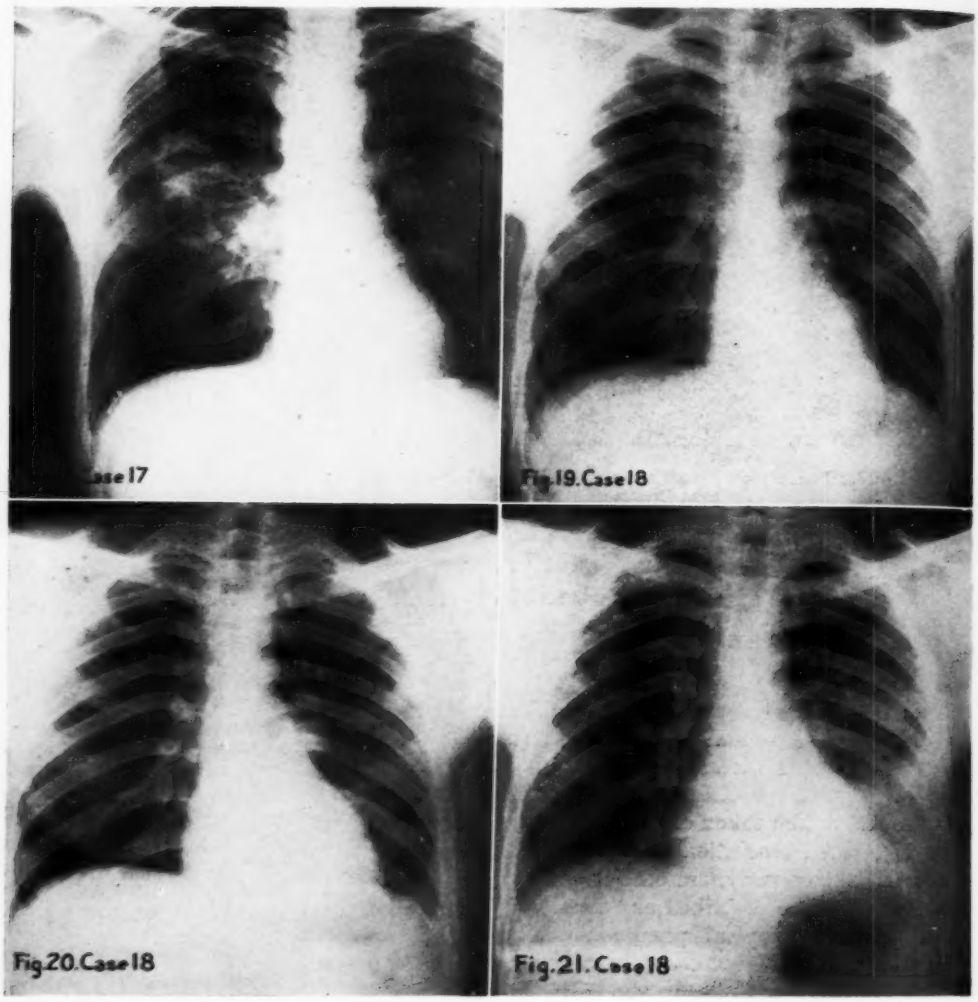
tion. At this time, all of the acute symptoms had subsided.

During the resolving stage of a bacterial pneumonia, the roentgen appearance may resemble a primary atypical pneumonia. The first roentgen examination (Fig. 16) in Case 16 (which proved to be a type VII pneumococcic pneumonia) was made at the height of the disease and showed a dense pneumonic consolidation in the right upper lobe. A film taken eleven days later (Fig. 17), when resolution of the process was well under way, resembled fairly closely the picture described as "classical" for a primary atypical pneumonia. It presented a striated increased density extending from the right hilum. If the roentgenologist were not aware that this was a resolving bacterial pneumonia, he might interpret the roentgenogram as one of a primary atypical pneumonia.

CASE 17: Pvt. A. R. O., aged 44, was admitted to the station hospital on May 27, 1943, with a history of a mild hacking cough for one week prior to admission. Roentgen study revealed a mottled increased density in the right hilum and the lower portion of the right upper lobe, consistent with a pneumonia. The temperature on admission was 98.6° F., pulse 74, and respirations 16 per minute. A few coarse râles were heard along the right sternal border. The patient remained afebrile during his entire hospital stay. A follow-up roentgenogram taken on July 9, 1943, showed complete resolution of the lesion. The case was diagnosed as a primary atypical pneumonia.

CASE 18: Pvt. W. J. C., aged 20, was admitted to the station hospital on April 17, 1943, complaining of cough, chills, fever, and pain in the left chest for one week, with expectoration of some rusty sputum on the day of admission. Physical examination revealed some fine moist râles over the left base. The temperature was 103.2° F., pulse 88, and respirations 22 per minute. The white blood count was 24,800, with 96 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study, April 17, 1943, revealed no radiographic evidence of a pneumonia. The patient was given sulfathiazole, which was continued for thirteen days. Further roentgen study, April 22, 1943, revealed a haze adjacent to the left cardiac border, suggestive of a beginning pneumonia. A definite homogeneous density characteristic of a pneumonia involving the left lower lobe area was seen on the roentgenogram of April 25, 1943. By this time, the patient had already responded to the sulfathiazole therapy and was greatly improved clinically. On May 3, an effusion developed in the left chest, which took forty days to become completely resorbed. Some residual pleural thickening remained at the time of discharge from the hospital.

We have found that in pneumonia there is no correlation between the amount of consolidation evident on the roentgenograms and the severity of the clinical symptoms. The amount of pulmonary exudate is not directly proportionate to the virulence of the disease. Either type of pneumonia may show anything from a slight bronchitic streaking to a consolida-



Figs. 18–21. Case 17. Primary atypical pneumonia. Case 18. Pneumococcic pneumonia.

tion. Case 17 is an example of what is frequently referred to as a "walking pneumonia." The patient was not ill except for a mild, hacking, unproductive cough, which was in no way incapacitating. Routine roentgen examination (Fig. 18) revealed the pneumonic process in the right upper lobe, the size, density, and distribution of which were entirely disproportionate to the clinical symptoms. Resolution was complete in twelve days.

Case 18, a pneumococcic pneumonia, type II, is presented for contrast. The first roentgenogram (Fig. 19) revealed negative findings in the face of indubitable symptoms and laboratory findings confirming the presence of a pneumococcic pneumonia, type II. Five days later roentgen study (Fig. 20) revealed a slight haze along the left cardiac border. On the eighth day of hospitalization, a definite pneumonia was present (Fig. 21). If an opinion were ventured on the first chest film, taken at the height of the illness, the roentgen interpretation would be bronchitic changes in the right cardiophrenic angle.

CASE 19: Pvt. J. F. W. G., aged 33, was admitted to the station hospital on May 6, 1943, with a cough of five days' duration and chills and fever on the day of admission. There were impaired resonance, harsh breath sounds, and crepitant râles over both lower lobes. The temperature was 101.8° F., pulse 112, and respirations 22 per minute. The white blood count was 18,400, with 90 per cent polymorphonuclear leukocytes. A pneumococcus, type II, was recovered from the sputum. Roentgen study of the chest, May 11, 1943, revealed a spherical mottled density with feathered edges in the right lower lobe. In the left lower lobe area was seen a homogeneous increased density. Both lesions were consistent with pneumonia. The patient made an uneventful recovery with sulfadiazine therapy.

This case was one of bilateral pneumonia (Fig. 22). In the right lower lobe a spherical area of consolidation was seen, the edges of which were feathered and seemed to merge imperceptibly into the surrounding tissue. This lesion resembled the type of shadow described as characteristic for primary atypical pneumonia. The left lung contained an area of consolidation of homogeneous density, demarcated from the surrounding pulmonary parenchyma. On the basis of the roentgen findings alone, the diagnosis would be a primary atypical pneumonia on the right and a bacterial pneumonia on the left. The patient actually had a type II pneumococcic pneumonia. There is no clinical reason for suspecting a coexistent atypical pneumonia. It is probable that one organism, the type II pneumococcus, was responsible for both lesions. The right lung reacted by producing one type of exudative process and the left lung responded in an entirely different manner. Variation in the tissue response is, therefore, an important factor in determining the roentgen appearances of the pneumonic process.

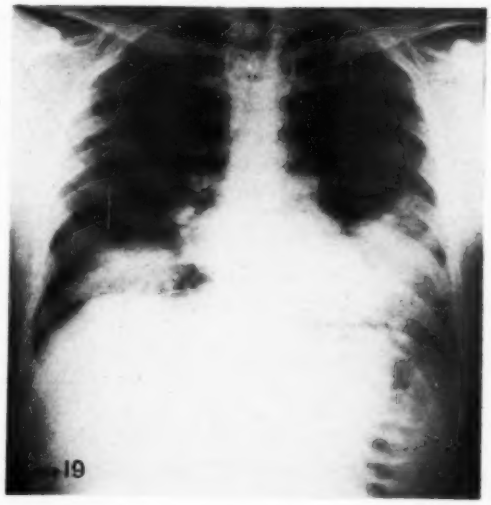


Fig. 22. Bilateral pneumococcic pneumonia.

SUMMARY AND COMMENT

Nineteen cases, representing a cross-section of over 2,000 pneumonias are reported. We have been impressed by the variability of the roentgen shadow during the course of both bacterial and primary atypical pneumonia. From the evaluation of our large number of serial roentgen studies of the chest in both types of pneumonia, we are convinced of the fallacy of employing rigid roentgenologic criteria to differentiate the two. Any attempt to establish an *etiological* diagnosis from the roentgen findings *alone*, without a knowledge of the clinical symptomatology, laboratory findings, and clinical course, is certain to result in inaccurate diagnoses.

NOTE: Acknowledgment is made to the post surgeon, ward officers, and technicians for their cooperation and assistance.

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Roentgen Study of Primary Atypical Virus Pneumonia[1]

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SMALL EPIDEMICS of virus pneumonia have been prevalent in this country since the fall of 1935. Since the disease is usually not fatal, there has been comparatively little pathologic material available for study. There appear, however, to be certain clinical, roentgenologic, and laboratory findings which help to form a fairly clear picture of the entity. This report is based on a study of 100 consecutive cases observed in the Department of Radiology of the Massachusetts Memorial Hospitals.

ETIOLOGY

Virus pneumonia is probably due to a filtrable virus, which has not yet been identified. Eaton, Beck and Pearson (1), discussing the cases described by Reimann (11), Kneeland and Smetana (5), and by Longcope (10), state that atypical pneumonia presents clinical similarities to cases of recognized psittacosis. They believe that the causative agent in some instances may be antigenically related to the virus of meningopneumonitis and psittacosis. Nigg (2) was able to produce pneumonia and systemic infection in mice with a virus similar in antigen relationship to the viruses described for psittacosis and lymphogranuloma venereum. Another possibly related form is suggested by the report of Adams, Green, Evans and Beach (3), who studied two epidemics of virus pneumonitis. They observed that, while every infant exposed to the disease became ill, adults showed a relative immunity. Their attempts to transmit the disease to mice or guinea-pigs were unsuccessful. Inclusion bodies were found in these cases, whereas none has been demonstrated at autopsy in virus pneumonia. Finland and Dingle (4) state that the white cell count may become elevated without any evidence of secondary bacterial invasion. Most observers are now of the opinion that bacterial invasion is rare or absent. According to Kneeland and Smetana (5), "secondary bacterial infection occurred so rarely as to make it seem that the disease might actually predispose against it."

SYMPTOMS

The symptoms vary with the severity of infection. They may be so mild as to go unrecognized, or they may be entirely out of proportion to the physical findings. They may be insidious in appearance, patients being unable to date their exact onset. The principal complaint is cough, soon followed by fever and malaise. The patient may diagnose his own condition as a "cold" and dismiss it lightly. In a few days, however, the intensity of symptoms increases. Fever may rise to 103° or 104°, or even higher. Coughing becomes more frequent and severe and may be productive of white, tenacious sputum. There may be pain in the chest and possibly also in the extremities. These may be associated with prostration, dyspnea, and cyanosis. The average duration of symptoms in our cases at the time of hospital entry was seven days.

CLINICAL AND LABORATORY FINDINGS

Except in mild cases, patients showed a varying degree of prostration. There was a dry, rasping cough accompanied by pain in the chest. In the moderate and severe infections cyanosis was often present. Physical examination showed hyperemia of the pharynx varying in manifestation from moderate redness to intense injection.

In the typical case, percussion often revealed normal resonance throughout both lungs, though areas of flatness were not

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rare. Fine, crepitant, inspiratory râles or coarse rhonchi could be heard on one or both sides, or were absent altogether. As Longcope (6) points out, there was marked disparity between the physical and roentgen findings in the lungs.

The white cell count varied. A few patients showed leukopenia or no departure from normal. In 80 per cent of our cases there was a leukocytosis at the time of hospital entry. Blood cultures were negative. Sputum smears and cultures revealed the usual microorganisms resident in the throat: diphtheroids, streptococci, staphylococci, Micrococcus catarrhalis.

Urinalysis frequently showed varying amounts of albumin, probably due to toxic nephritis. There was no other significant finding.

PATHOLOGY

The initial lesion of virus pneumonia is a severe tracheobronchitis. There are proliferation and sloughing of the bronchial epithelium, and epithelial exudate fills the bronchial lumen. The walls of the smaller bronchi become necrotic (7). As the inflammation extends into the lungs, a severe peribronchitis is set up, so that at this stage the lesions are interstitial.

The pathologic process is destructive and entirely different from the inflammatory exudates seen in pneumococcal pneumonia (6). In the comparatively few autopsied cases reported in the present epidemic (5, 8, 9, 10) the lungs were found to be red and edematous. There were small areas of focal or lobular atelectasis, some of which coalesced to form larger areas, as well as areas of emphysema. The alveoli contained chiefly mononuclear cells, erythrocytes, and coagulated serum. Fibrin was lacking. An occasional hyaline membrane was present, and edema fluid often filled the alveoli. The tracheobronchial system showed areas of necrosis, the predominating cells in these regions being polymorphonuclear leukocytes. Thrombosis of the smaller branches of the pulmonary artery has been observed. The fact that abnormal signs and roentgenographic shadows persisted so long in some cases suggested to Reimann (11) that the interstitial tissue was severely damaged.

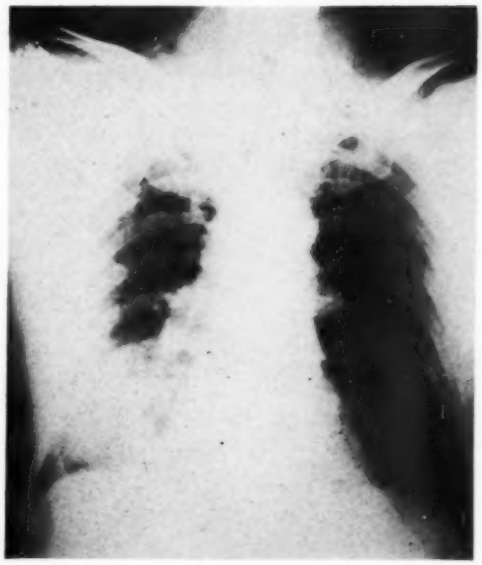

Fig. 1. Bedside roentgenogram of fatal case of virus pneumonia. There is consolidation at the right base. Note the mottled density and low right diaphragm due to emphysema. The intercostal spaces are not narrowed. These changes distinguish consolidation in virus pneumonia from pneumococcal pneumonia.

Male, age 62 years; duration of illness 4 days. Temp. 105.6°. WBC 10,000. Sputum: diphtheroids, streptococci with alpha hemolysis, M. catarrhalis. Blood culture: no growth.

In our series, one case uncomplicated by other disease terminated fatally. Microscopic study revealed changes which resembled "influenzal" rather than bacterial pneumonia. There were scattered areas of focal atelectasis and emphysema. A hyaline membrane lining the alveoli was frequently observed. There was monocytic infiltration and some fibrin was present (Figs. 1 and 2).

ROENTGENOLOGIC APPEARANCE

The earliest change in virus pneumonia appears as a tracheobronchitis. There are hazy shadows in one or both hilar regions and increased prominence of the bronchial markings. The lungs are luminous and the diaphragm is low (Fig. 3). As the disease progresses, the bronchial

markings become wider and more hazy and there is more or less dense, linear infiltration following the course of the bronchi. The appearance at this time is that of a peribronchitis or interstitial pneumonia (Fig. 4). The lung in the involved region has a diminished radiolucency, while the peripheral portions are emphysematous. Small dense areas of atelectasis and edema having a bronchial distribution soon appear and may coalesce (Fig. 5). When coalescence occurs, the area of consolidation is usually not of such uniform density as in lobar pneumonia but has a coarsely mottled appearance. Moreover, the disease has a tendency to involve only a portion rather than an entire lobe. The most extensive changes are usually seen in the middle and lower parts of the lungs. The signs of gross atelectasis, such as narrowing of the intercostal spaces, shift of the heart to the affected side, and elevation of the diaphragm, are found infrequently, because of associated emphysema, whereas they are usually present in pneumococcal pneumonia.

With the onset of resolution, the minute areas of atelectasis and edema in the peripheral areas of the lung begin to disappear, the process extending centripetally toward the hilum (Fig. 6). This is in contrast to the resolution usually observed in bacterial pneumonias, in which resolution proceeds *from* the hilum (12). At this stage the lungs are quite luminous and are traversed by numerous coarse lines which radiate fanwise from the lung roots. Sometimes the peripheral portions show a coarse network. Subsequently resolution proceeds much more slowly, the linear infil-

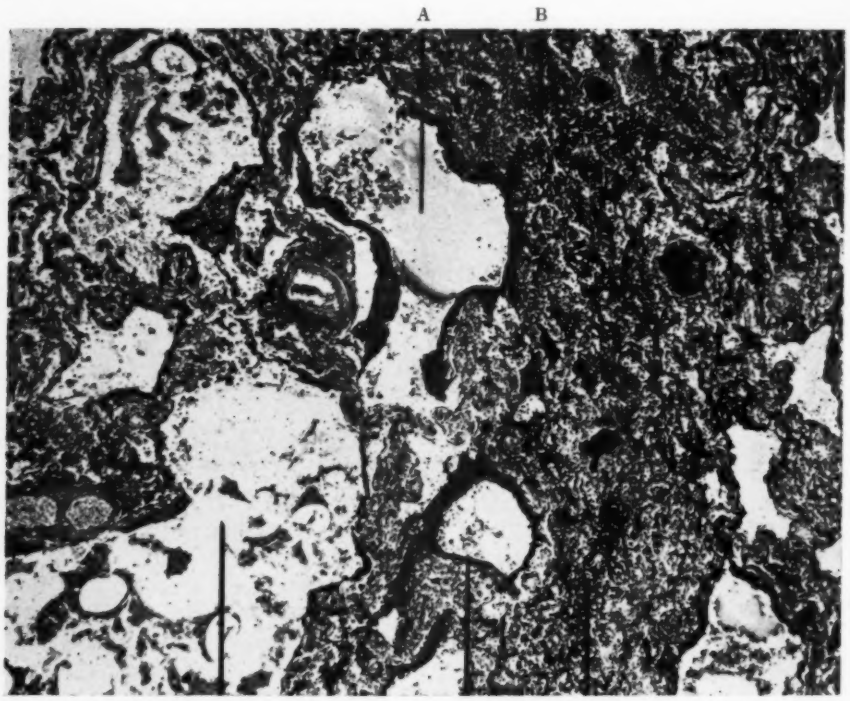

Fig. 2. Photomicrograph of lung from case shown in Fig. 1. A. Edema fluid. B. Atelectasis. C. Emphysema. D. Hyaline membrane. E. Endothelial infiltration and fibrin. Zenker fixation. Phloxine-methylene-blue stain. ×140.

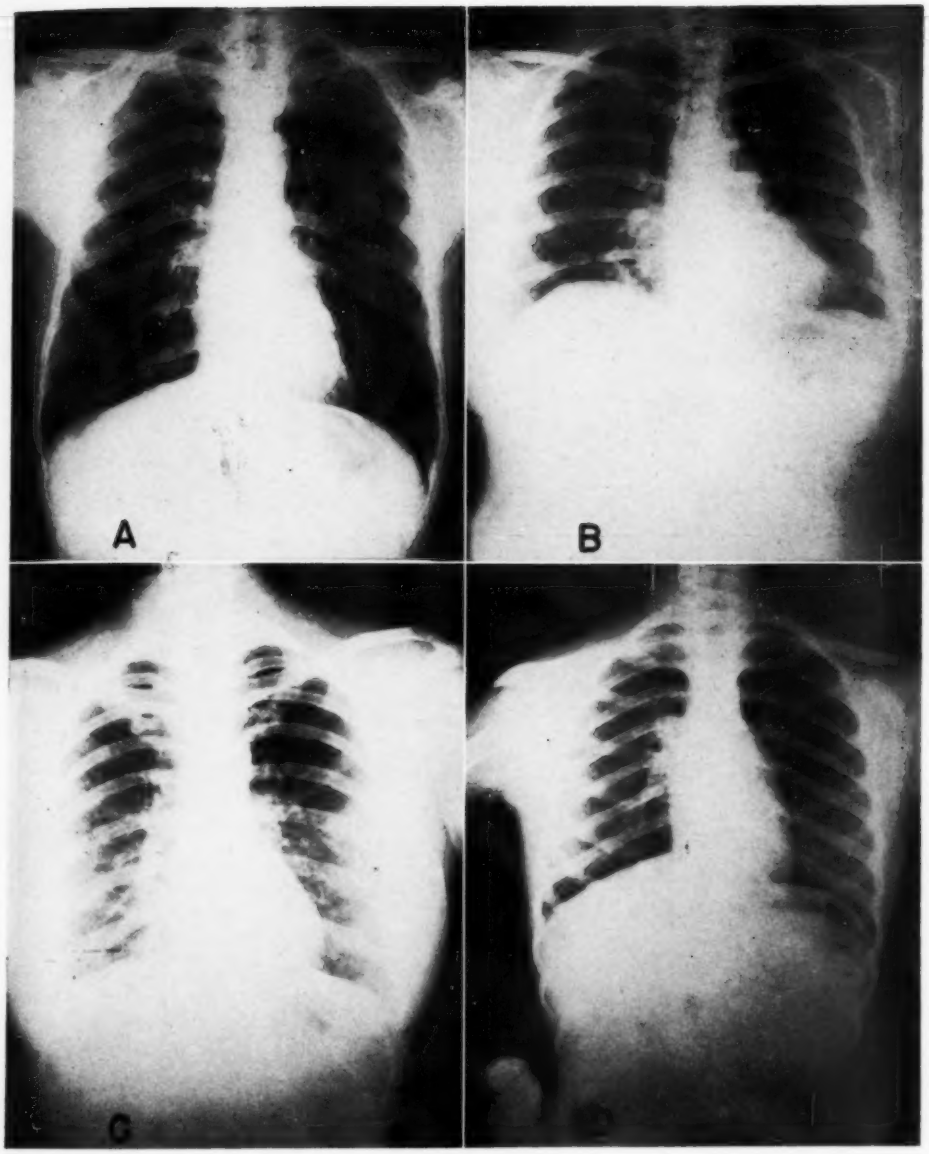

Fig. 3. Earliest changes of virus pneumonia. The hilar shadows are enlarged and the linear markings are increased. These changes are due to tracheobronchitis. Note low position of diaphragm.

A. Male, age 38 years; duration of illness 4 days. Temp. 100.8°. WBC 8,900. Throat culture: streptococcus with slight beta hemolysis, diphtheroids, Staph. albus. Blood culture: no growth.

B. Female, age 45 years; duration of illness 1 day. Temp. 101°. WBC 10,000. Sputum: alpha streptococcus, Staph. albus, hemolytic Staph. aureus. Blood culture: no growth.

C. Female, age 44 years; duration of illness 4 days. Temp. 101°. WBC 8,500. Sputum: Staph. albus, diphtheroids, M. catarrhalis. Blood culture: no growth.

D. Female, age 12 years; duration of illness 3 days. Temp. 101.6°. WBC 11,600. Sputum: M. catarrhalis, Staph. albus.

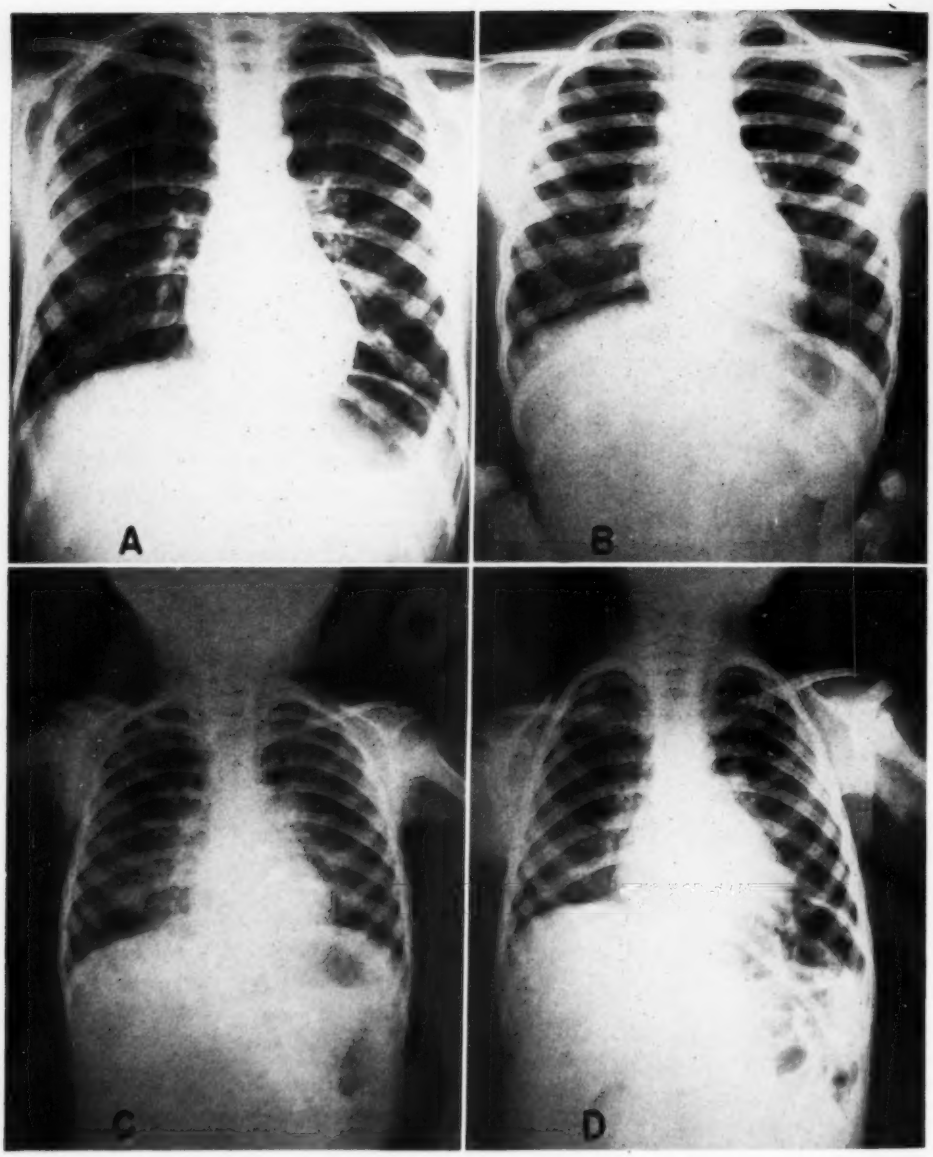

Fig. 4. Further progress of the disease. At this time there is evidence of interstitial pneumonitis. Note the absence of signs of gross atelectasis.

A. Male, age 9 years; duration of illness 10 days. Temp. 101.4°. WBC 17,700. Throat culture: alpha streptococcus, Staph. albus, Strep. viridans, diphtheroids, M. catarrhalis. Blood culture: no growth.

B. Female, age 6 years; duration of illness 9 days. Temp. 102.8°. WBC 8,700. Throat culture: Streptococcus with alpha hemolysis, M. catarrhalis, diphtheroids; K.L. negative. Blood culture: no growth.

C. Male, age 2 years; duration of illness 2 days. Temp. 103.6°. WBC 10,600. Throat culture: Strep. viridans, Staph. albus, diphtheroids. Blood culture: no growth.

D. Female, age 3 years; duration of illness 2 days. Temp. 102°. WBC 12,000. Throat culture: alpha streptococcus, M. catarrhalis, diphtheroids; K.L. negative.

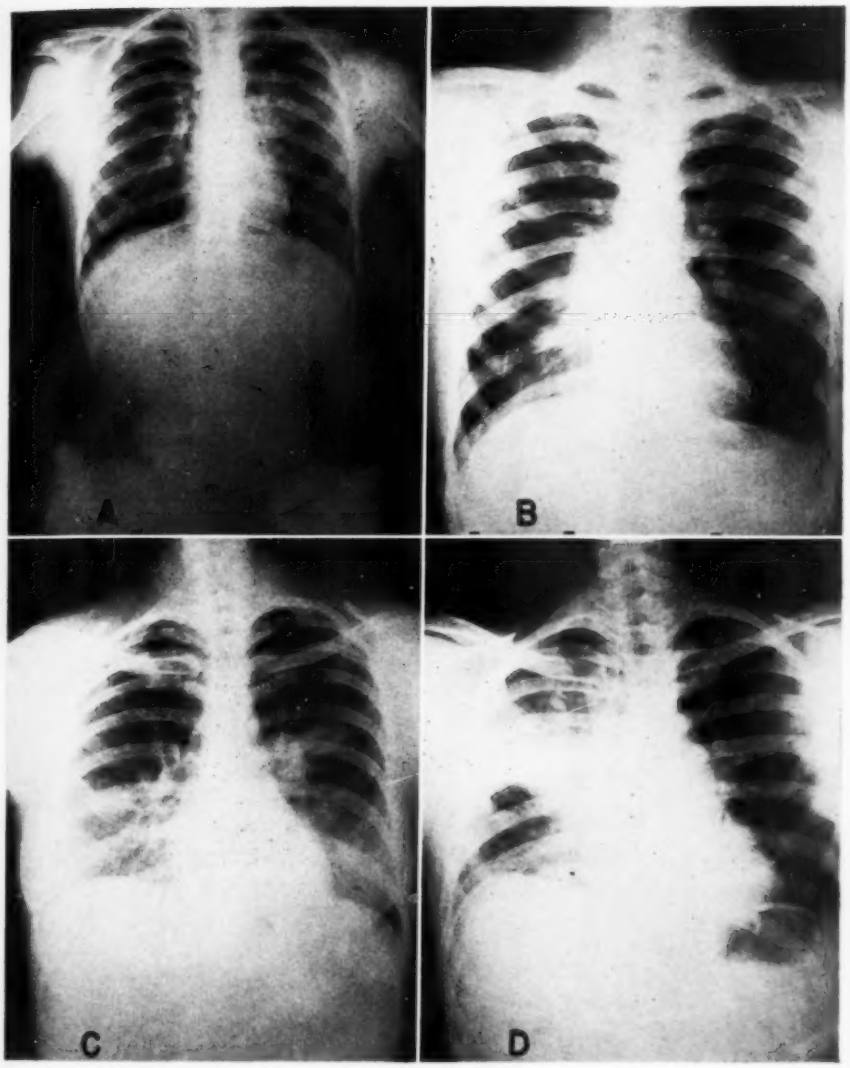

Fig. 5. Further progress of the disease. There is coalescence of atelectatic foci. These areas lack the homogeneous consolidation seen in pneumococcal pneumonia, and consolidation usually involves only a portion of a lobe (D). Note that the diaphragm is not elevated. This is due to the presence of emphysema in association with atelectasis.

A. Female, age 10 years; duration of illness 10 days. Temp. 101.8°. WBC 25,500. Sputum: streptococcus with alpha hemolysis. Blood culture: no growth.

B. Male, age 21 years; duration of illness 5 days. Temp. 103.8°. WBC 14,500. Sputum: streptococcus with alpha hemolysis, M. catarrhalis, diphtheroids. Blood culture: no growth.

C. Female, age 26 years; duration of illness (?). Temp. 99°. WBC 6,050. Sputum culture: Strep. viridans, alpha staphylococcus. Blood culture: no growth.

D. Male, age 24 years; duration of illness 7 days. Temp. 101.4°. WBC 8,850. Sputum: Staph. albus, streptococcus, M. catarrhalis. Blood culture: no growth.

tration or network occasionally persisting for weeks or months. In one of our cases there was no change in the roentgenologic appearance of the lungs for fifty-two days, in spite of the fact that the patient was clinically well.

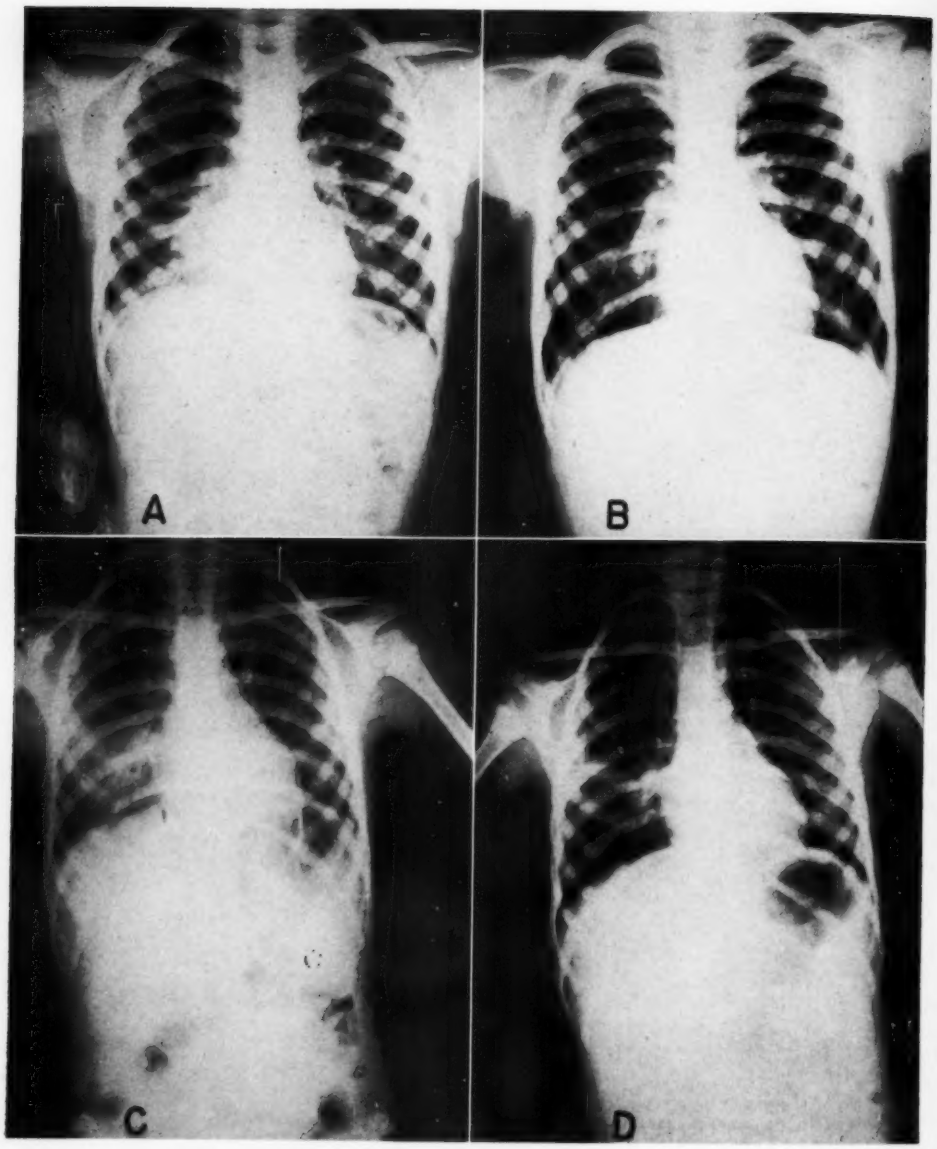

Fig. 6. Resolution proceeds centripetally from the periphery to the hilum. This is in contrast to the type of resolution usually seen in pneumococcal pneumonia.
A. Male, age 7 years; duration of illness 1 week (?). Temp. 101°. WBC 9,000. Sputum: Strep. hemolyticus, Staph. albus, diphtheroids. Blood culture: no growth.
B. Same patient as A, 11 days later.
C. Female, age 4 years; duration of illness 6 days. Temp. 105.8°. WBC 22,000. Throat culture: Strep. hemolyticus, Staph. albus, diphtheroids. Blood culture: no growth.
D. Same patient as C, 4 days later.

While resolution is taking place in one lobe, the process may appear anew in another lobe, or the same lobe may be reinvolved after resolution has already occurred. This may be explained by the fact that the disease essentially involves

the tracheobronchial tree, allowing for easy dissemination to other foci during paroxysms of severe coughing. In general, complete resolution is slower than in pneumococcal pneumonias and may not be complete for weeks or months. Pleural effusion is usually absent.

During the course of the disease the roentgenologic appearance may vary considerably. The picture may simulate tuberculosis, lobar pneumonia, bronchopneumonia, abscess, bronchiectasis, metastatic carcinoma, or pulmonary edema, and the diagnosis may rest largely on the history and the clinical and laboratory findings, as well as serial chest films. Sante (13) has likened the appearance to the changes seen in pulmonary toxoplasmosis and to pulmonary edema. In these conditions, however, there is no emphysema. This feature serves to distinguish virus pneumonia.

Focal atelectasis in virus pneumonia is apparently due to a variable degree of bronchiolar obstruction and may appear at any stage of the disease. It is essentially different from the atelectasis of pneumococcal pneumonia, which is produced in the alveoli by accumulation of inflammatory exudate and absorption of residual air. Varying degrees of atelectasis may persist long after the patient is clinically well.

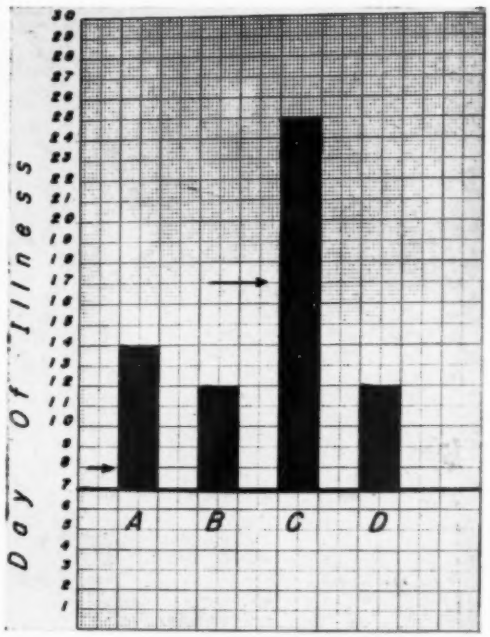

Fig. 7. Chart showing relation of roentgenologic findings to physical signs, fever, and leukocytosis. Average duration of illness at time of hospital entry, 7 days. A. Leukocytosis (present in 80 per cent of cases); arrow indicates day of highest count. B. Fever. C. Abnormal roentgen findings; arrow indicates day of average beginning resolution. D. Physical signs.

DISCUSSION

From a roentgenologic standpoint, virus pneumonia appears to be a disease of the tracheobronchial system with secondary changes in the lungs. Accumulation of inflammatory exudate in the bronchi results in the production of scattered small areas of atelectasis and emphysema. This is accompanied by interstitial inflammation. In our series, the average duration of symptoms at the time of admission to the hospital was seven days (Fig. 7). At this time there were positive findings in all of the chest roentgenograms. How much earlier these can consistently be found we are not able to say, though a few patients admitted on the first day of their illness showed evidence of acute tracheobronchitis. McCarthy (14) states that evidence of the disease appears on the films on the fourth day.

The lack of proportionately advanced physical findings in the chest may be explained partly by the presence of acute emphysema, which could readily mask small areas of atelectasis or consolidation. Roentgen examination is therefore important in determining the nature and extent of the disease. In a study of an institutional outbreak of pneumonitis, Hornibrook and Nelson (15) found that roentgen examination of the chest gave the most typical and consistent evidence of pulmonary lesions.

Kneeland and Smetana (5) found the average white cell count to be 10,000, though in two of their cases it reached 50,000. Leukocytosis was present in 80 per cent of our cases (Fig. 7). The average white cell count reached its highest on the

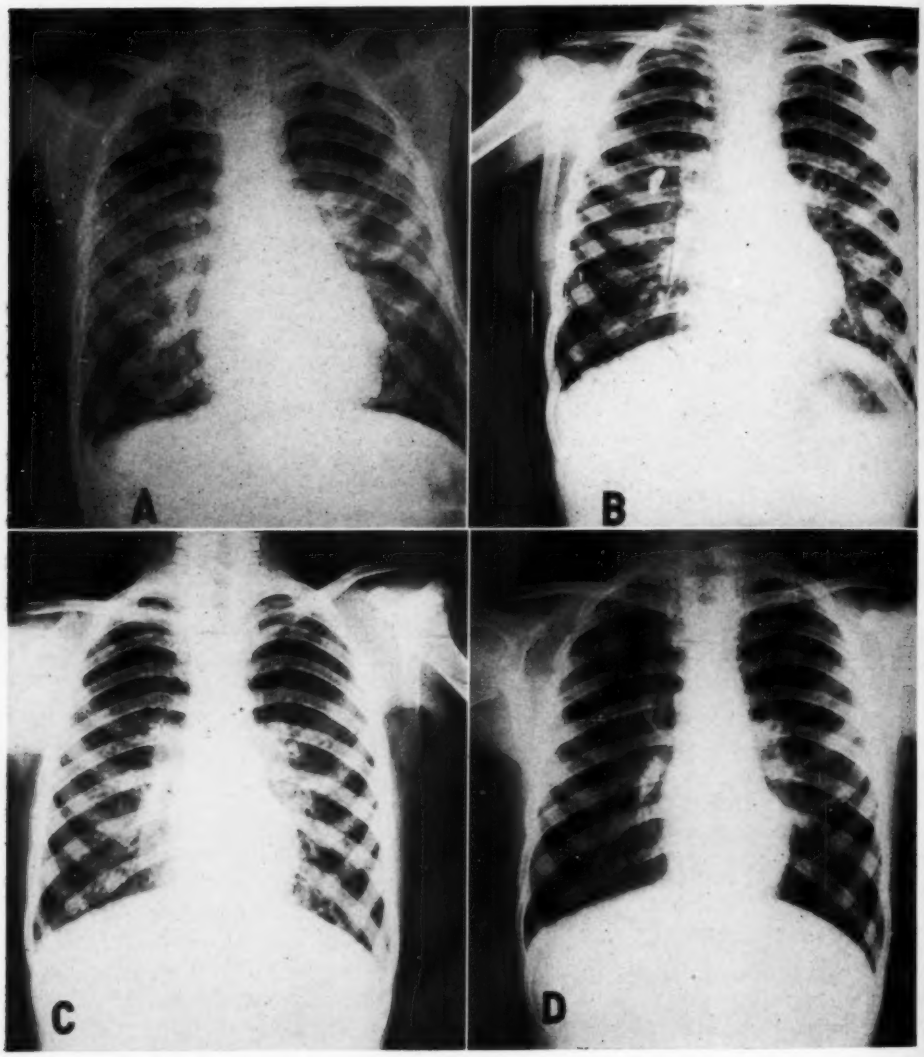

Fig. 8. A. Male, age 9 years; duration of illness 17 days. Temp. 101.4°. WBC 30,000. Sputum: Staph. aureus, Strep. viridans, diphtheroids. Blood culture: no growth. There is diffuse interstitial pneumonia with multiple areas of atelectasis and emphysema.

B. Same patient 11 days later. There is clearing from the periphery. Temp. 98.6°. WBC 15,000. Sputum and blood culture as before.

C. Same patient 29 days after B. Temp. 100.8°. WBC 24,000. Hilar shadows are increased, indicating reinfection.

D. Same patient approximately 13 weeks after C. Temp. 97.8°. WBC 8,600. There is no clinical evidence of disease. There is persisting roentgenologic evidence of interstitial pneumonitis involving medial portions of both lungs. Note presence of emphysema throughout entire course.

eighth day after onset of illness and returned to normal on the fourteenth day. The average day on which temperatures returned to normal was the twelfth.

In our series, roentgen changes persisted longer than clinical signs or abnormal laboratory findings. All cases showed positive pulmonary findings on the roentgenograms taken on admission. On the average, clearing of the lung fields as shown

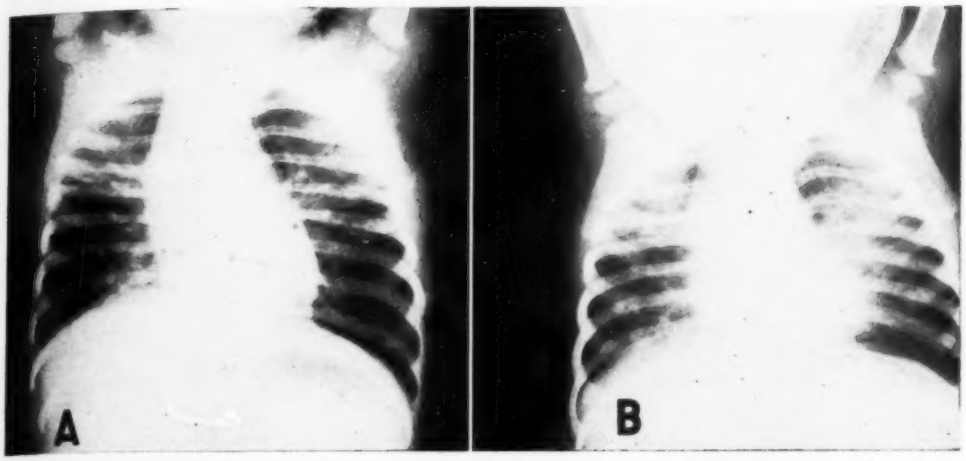

Fig. 9. Female, age 8 months; duration of illness 3 days. Temp. 105.4°. WBC 14,700. Throat smear: alpha streptococcus, Staph. viridans, and Staph. albus.

Film taken on admission (A) shows tracheobronchitis, multiple small areas of atelectasis, partial atelectasis of right upper lobe, and emphysema. There was progressive improvement for 5 days. On the 6th day (B) there was reappearance of fever (102°); WBC 9,700. Film shows reinfection of both lungs, persisting atelectasis, right upper lobe.

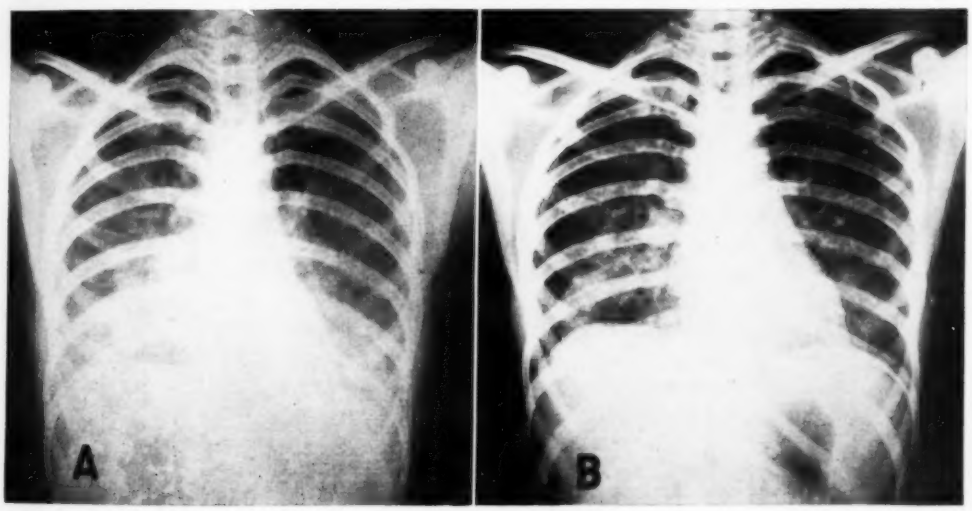

Fig. 10. A. Female, age 19 years; duration of illness 10 days. Temp. 98.6°. WBC 12,800. Sputum: Staph. viridans, diphtheroids. Blood culture: no growth. Film shows multiple areas of focal atelectasis having a bronchial distribution. Subsequently there was increase of fever and leukocytosis with the appearance of severe cyanosis and dyspnea.

B. Same patient 52 days later. Patient discharged as clinically well. Partial atelectasis and interstitial pneumonitis persist.

roentgenographically occurred on the seventeenth day. This consisted chiefly of resolution of areas of pneumonic consolidation or atelectasis (Fig. 8). In cases showing exacerbation due to involvement of previously unaffected lung (Fig. 9), the duration of the disease was necessarily prolonged. In most cases, however, there was a persistence of peribronchial and perivascular thickening and emphysema.

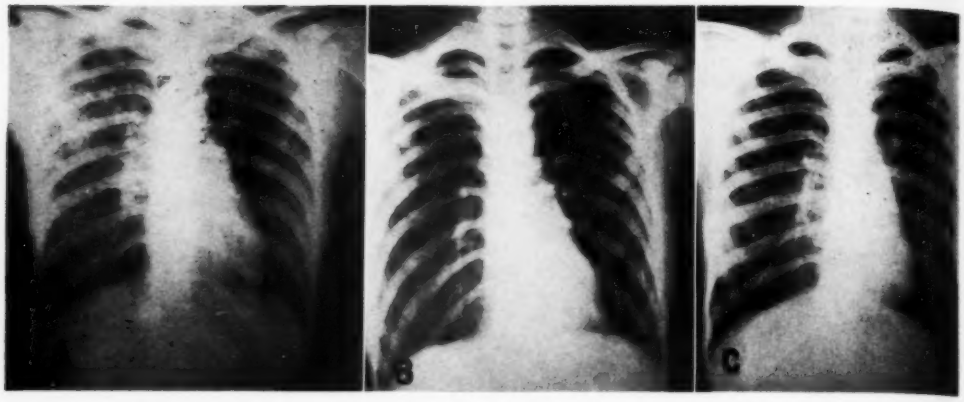

Fig. 11. A. Female, age 18 years; duration of illness 10 days. Temp. 103.8°. WBC 8,200. Sputum: Staph. aureus, Staph. viridans. Blood culture: no growth. Note multiple areas of atelectasis and edema in right lung together with generalized emphysema. The diaphragm is low. There is no gross atelectasis.
B. Same patient 8 days later. Temp. 98.6°. WBC 7,800. Blood culture: no growth. Film shows partial resolution.
C. Same patient 5 days after B (day of discharge). Temp. 98.6°. WBC 9,980. There is a residual network in the parenchyma and the hilar shadows are thickened. At this time patient was clinically well. (Check-up film taken 2 months later showed no residual evidence of disease.)

The average day for disappearance of all residual roentgenologic evidence of the disease was the twenty-fifth. This is in substantial agreement with the observations of Dingle and his associates (9), who found that the x-ray signs disappeared on the twenty-sixth day. They reported a persistence of physical signs, however, up to the fortieth day. The earliest complete resolution in our series occurred on the fourth day. The other extreme was a case which showed very little change in the roentgenologic appearance of the lungs in fifty-two days (Fig. 10). Except for occasional râles, the lungs were found clear on physical examination on the twelfth day.

The persistence of roentgenologic findings long after apparent clinical cure suggests the possibility of the development of chronic complications, particularly bronchiectasis. For this reason, it would appear to be good practice to take a roentgenogram of the chest on the day of discharge and another, where indicated, at a short interval thereafter (Fig. 11).

SUMMARY AND CONCLUSIONS

1. Virus pneumonia produces fairly characteristic pulmonary changes as shown by roentgenologic examination. These consist of tracheobronchitis, peribronchitis, focal atelectasis, edema, and emphysema. The presence of emphysema militates against total lobar atelectasis, so that uniform consolidation is infrequently observed.

2. Roentgenograms show clearing of the lungs on the seventeenth day and a return to normal on the twenty-fifth day.

3. Resolution progresses centripetally, the peripheral portions of the lungs being the first to clear.

4. Roentgenologic evidence of interstitial pneumonitis and partial atelectasis may remain long after clinical cure.

NOTE: We wish to acknowledge with thanks the assistance of Dr. Chester S. Keefer, Physician-in-Chief of the Massachusetts Memorial Hospitals and Director of the Evans Memorial; of Dr. Sidney Farber, Pathologist of the Children's Hospital, Boston, who reviewed the pathologic material, and of Dr. Charles F. Branch, Pathologist of the Massachusetts Memorial Hospitals.

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Tomography in the Region of the Maxillary Sinuses[1]

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THE PURPOSE of this paper is to present the normal tomographic landmarks in the region of the maxillary antra and to compare them with certain abnormalities of these parts. The work now reported is part of a more complete study to be published later.

Although tomograms do not give distinct and detailed views of bony structures, they have the advantage of disclosing features which are obscured in ordinary roentgenograms by overlying and underlying bony structures and by certain soft tissues. Especially is this true in the field of cancer.

While serving as a visiting fellow of the Chicago Tumor Institute in 1938, Felix Leborgne of Montevideo, Uruguay, constructed a simple tomographic apparatus similar to one he had designed and previously described. The main features of this unit are its simplicity and economy. So far as we know, it was the first equipment of this type installed in this country.

A review of the literature of tomography discloses numerous publications, but for the most part these are limited to case reports. Leborgne (1, 2, 3) was the first to publish comprehensive studies of tomography with reference to abnormalities in a limited anatomical field, namely, cancer of the larynx. Caulk (4) has also contributed to the subject. Moore (5, 6, 7) has written extensively on the value of this type of roentgenography and is a pioneer in the field. In dental radiography the value of the tomogram has been demonstrated in temporomandibular joint abnormalities by Costen (8), Peyrus and Aubert (9), and Pippin and his associates (10). Cone, Moore, and Dean (11) have reported on the use of tomography of the paranasal sinuses in ocular disorders due to disease of these chambers. Epstein (12) has recently published a report on the tomographic study of skull abnormalities. Abnormalities of the skull, larynx, and lungs are especially well shown by this technic.

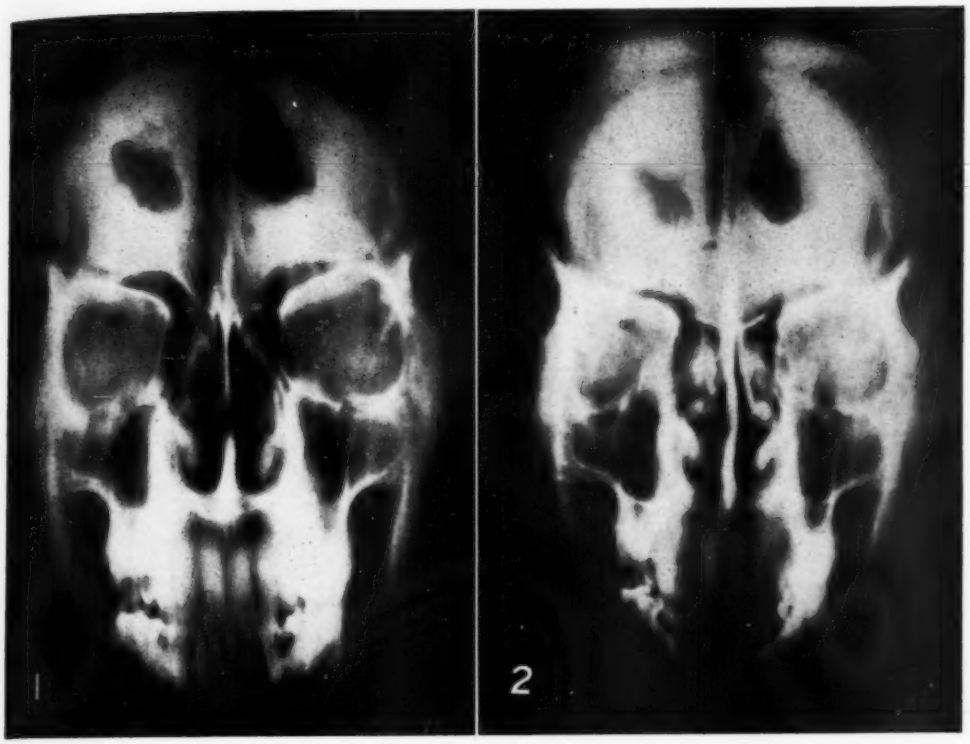
We have made a series of tomographic films at 0.5-cm. levels through the head of an adult cadaver in the anteroposterior projection. A similar study was made in the lateral projection, on another cadaver head. The present paper is concerned only with anteroposterior views at the level of the mid-portion of the maxillary sinuses.

Obviously, a clear conception of the features demonstrable by tomography can be obtained only by a comparison of successive adjacent levels. In this manner, a pathologic process can be followed from the point where it is first evident to the area where it is lost in normal bone architecture.

NORMAL TOMOGRAPHY

Figure 1, taken 5.0 cm. from the table top, is at the level of the central and lateral incisor teeth. The floors of both atria are well outlined and rather sharp in detail. The anterior maxillary sinus septa are readily seen. The shadow cast by the lateral wall of the posterior portion of the maxilla is seen to bisect each antrum (designated here and in films to follow as the "H" line). It is not a septal image, with which it is sometimes confused. This line in deeper films is seen to approximate closely the linear shadow cast by the posterolateral wall of the frontal bone, the lateral wall of the greater wing of the sphenoid (in most part), and the wall of the anterior squamous portion of the temporal bone ("R" line). At this level, too, both atria extend well into the zygomatic arch, the inferior border of which is clear and well defined. The supraorbital sinuses are well

[1] This work has been aided by the Maurice I. Weil Memorial Fund. Accepted for publication in November 1943.



Figs. 1 and 2. Normal tomograms at level of central and lateral incisor teeth, 5.0 cm. from table top (1) and at the level of the canine teeth (2).

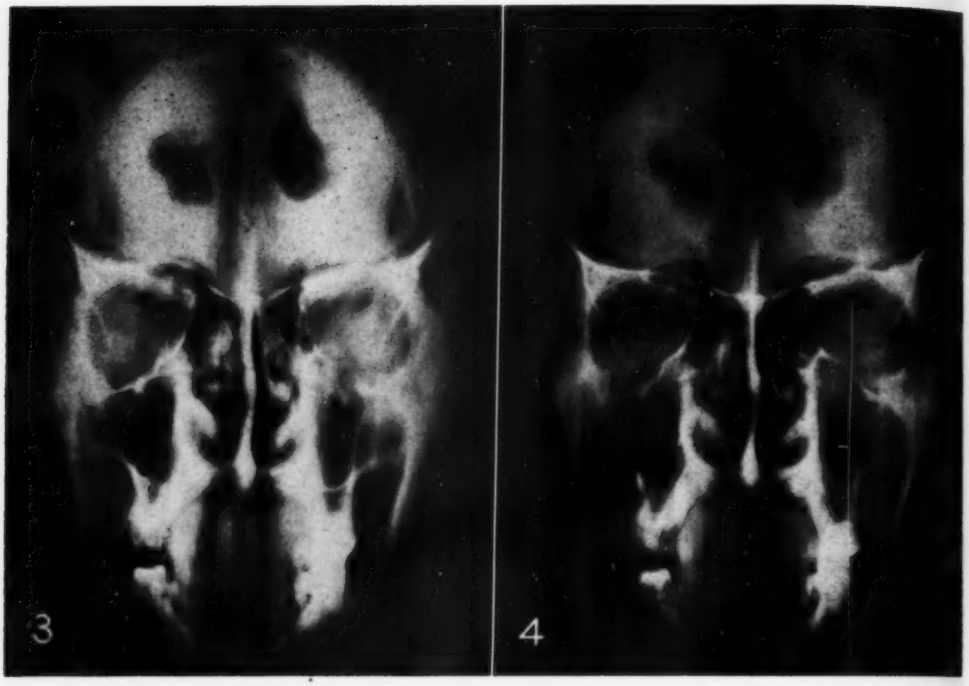
illustrated in this particular skull. Embryologically a portion of the ethmoidal air cells, these sinuses are forced anteriorly and laterally by the ethmoids and pneumatize that portion of the frontal bone immediately above the orbit and posterior to the true frontal sinuses. Like the frontal sinuses, these sinuses vary greatly in shape, and in some skulls they may be entirely absent. (The quite common failure of surgical procedures upon the frontal sinuses is attributed by many to the presence of infection within these supraorbital cells.)

The middle ethmoidal air cells are seen, as well as the lamina papyracea of the medial orbital wall. The crista galli is being lost to view. The inferior turbinates are coming into focus and are well delineated in deeper tomograms.

Because the skull is that of a cadaver, the lateral cerebral ventricles are neither uniform nor normal in size or shape and they are quite distinctly visualized. This is because the skull was exposed to the air for some time and the ventricles were fluid-free. In ordinary tomograms the ventricles are not seen.

In Figure 2, certain changes in the shape of structures previously noted are seen. The level is at the canine teeth. The crista galli is fading from view and the cribriform plate is well seen. The supraorbital sinuses are smaller, and what may be the orifice of this sinus into the ethmoidal air cells is noted on either side. The ethmoid cells are clear and the middle turbinate is seen for the first time. The orbits are smaller and are losing their spherical outline, becoming triangular in shape. The lamina papyracea is no longer clearly seen. The beginning of the superior orbital fissure is just made out in the superior portion of the right orbit.

Both atria are now more triangular than



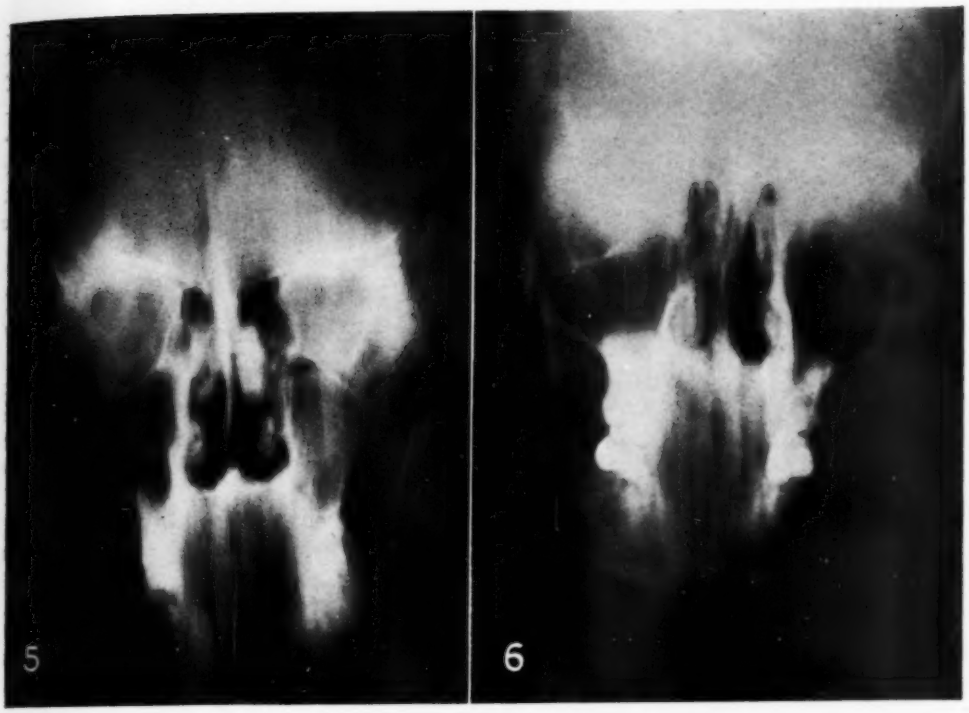
Figs. 3 and 4. Normal tomograms at level of first molars (3) and at level 6.5 cm. from table top (4).

previously and the walls more closely approximate a straight line. Septa are visualized and the floor of the left infraorbital canal is seen at the apex of the left antrum. The "H" and "R" lines are approaching one another on the left side.

Figure 3 is at the first molar teeth level. The supraorbital sinuses are disappearing. The middle turbinates are in sharp focus, especially on the left side, while the inferior turbinates are being lost to vision. The middle and posterior ethmoidal air cells are well visualized. The orbits are still smaller and more triangular. At this level the extremely thin inferior orbital wall can be seen near the antrum. (The frequent occurrence of interorbital extension of antral cancer thus becomes easily understood.) The superior orbital fissures are coming into clearer detail. The maxillary sinuses show no striking dissimilarity from the previous film. The "H" and "R" lines are still closer on the left side. Tongue substance is seen for the first time.

Descending in the anteroposterior plane to Figure 4, taken at a level which is now 6.5 cm. from the table top, we find that the supraorbital sinus on the left has been completely lost to view and only a small remnant of that on the right side is still seen. The posterior ethmoidal air cells are still clearly demonstrated, and both the middle and inferior turbinates are receding from focus. The orbits are becoming smaller and both superior orbital fissures are now evident. (The inferior orbital fissure is never well seen in anteroposterior tomograms.)

The medial portions of both maxillary sinuses are now elongated from above downward into the maxillary alveolar ridge, and the lateral extensions of the antra into the zygomatic arch are smaller. The "H" and "R" lines have almost approximated one another on the left side. (Both these lines curve abruptly medialward, the "H" line forming the inferior wall of the inferior orbital fissure and the



Figs. 5 and 6. Two cases of chronic sinus infection (Cases 1 and 2).

"R" line forming the superior wall of this same fissure in the skull. Thus they never actually approximate. The relationship of these lines to one another varies in the individual skull. In some they are almost in the same vertical plane, while most frequently the "H" line is somewhat medial to the "R" line.) The molar teeth are now in view.

INFECTIONS OF THE ANTRUM

Figure 5 illustrates a case of chronic left maxillary sinusitis (Case 1) in a young man 29 years of age with a history of typical acute exacerbations over a period of eight years.

This film shows a confluent, dense opacity involving all of the left antrum except its extreme apex, the level simulating one of fluid within the cavity of the sinus. In addition, the left ethmoidal air cells are completely obscured by a similar confluent opacity; however, it is seen that all the walls of the antrum are intact. Also, there is some increase in density of the base of the right antrum. This also assumes a level and is sharply demarcated laterally. It is believed that this represents infectious material trapped in this area and limited by a septum which arises from the inferior aspect of the sinus.

Comparison with the normal tomograms shows this particular film to be at the approximate level of Figure 4. The supraorbital sinuses are just disappearing, as are both the inferior and middle turbinates. The orbits are small and triangular and the posterior ethmoidal sinuses are well delineated. Also the tomogram is at the level of the molar teeth of the maxilla. Tongue substance is not sharply defined. There is a moderate right septal deviation.

Figure 6 represents chronic sinusitis (Case 2) in a young woman 28 years of age with a history of repeated attacks of sinus infection over a period of almost ten years.

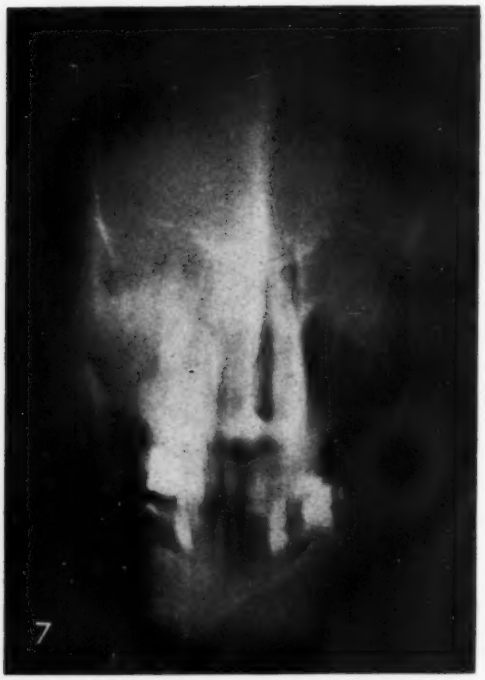


Fig. 7. Cancer of the maxillary sinus (Case 3).

Because of difference in radiologic technic, certain features are not seen in this film as in previous roentgenograms, but it does reveal the extent of infectious disease and is presented for that reason. The orbital walls are just faintly seen. The "R" line is discernible on the left, as is the inferior edge of the "H" line at the base of the left antrum.

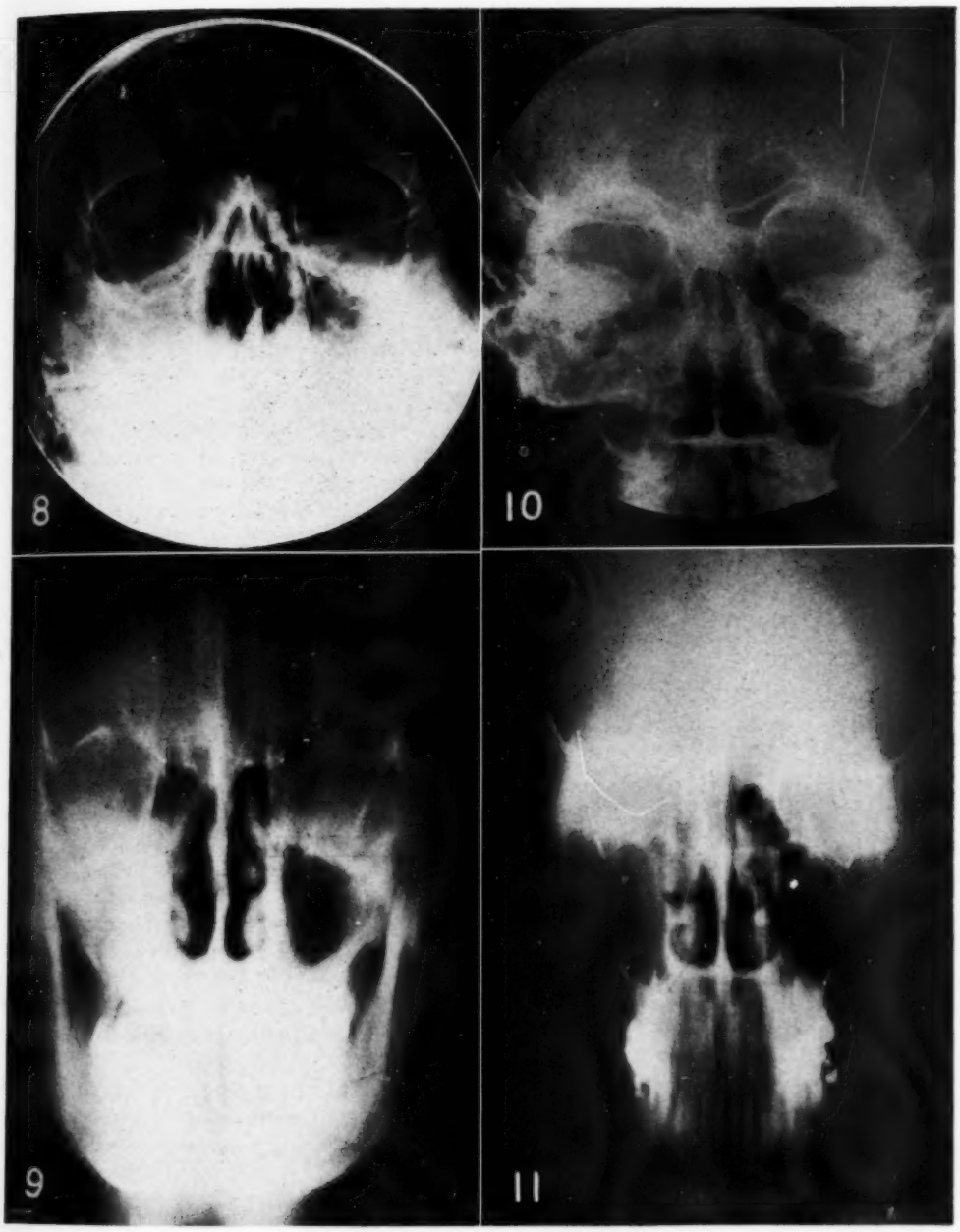
The entire right antrum is completely clouded by a rather dense opacity. The base of the left antrum is likewise involved. All antral walls, however, are intact. Edema of both the right inferior and middle turbinates is well shown and the ethmoids are clouded bilaterally, both middle and posterior cells being involved. The level of the tomogram is seen to bisect the maxillary molar teeth bilaterally.

These two cases disclose features which are constant tomographic findings in infectious antral disease. No pathologic disturbances are observed in the limiting walls of these sinuses. They are symmetrically alike, and there is no thinning of bony structures or actual osseous invasion. Usually a concomitant extension of the disease process to adjoining ethmoidal sinuses is observed and edema of the contiguous turbinates and sometimes of the mucosal wall of the naris is evident. The intact osseous walls of the sinus, however, are most important in the roentgenologic diagnosis.

CANCER OF THE MAXILLARY SINUS

Figures 7 to 11 show three cases of antral carcinoma, all involving the right maxillary antrum and all disclosing certain characteristics of cancer in this particular area. Ordinary roentgenograms of the last two cases are presented to illustrate the value of the tomogram in revealing detail not apparent in the ordinary films.

Figure 7 is one of extensive carcinoma (Case 3) in a man 69 years of age with right exophthalmos, disturbed vision, and complete blockage of the right naris. In this film, the level is at the maxillary teeth bilaterally. A dense opacity involves the entire right antrum. The inferior antral wall clearly shows destruction. There is no evidence of remaining medial antral wall, and the soft-tissue density overlies this area and completely obliterates the right nasal cavity. Superiorly, there are destruction of the inferior orbital wall and extension of the process within the orbit itself. This tomogram shows all but the superior wall of the right orbit to be clouded by the density. The opacity extends medially and upward to involve both the middle and posterior ethmoids, a frequent occurrence. The "H" and "R" lines are obscured on the right but are well delineated on the left side of the skull. There is slight cloudiness, probably infectious in nature, of the left antrum. There are moderate edema of the left middle and inferior turbinates and slight cloudiness of the middle and, to a lesser degree, of the posterior ethmoidal air cells on the left. The turbinates are not seen on the affected side. The left orbit is small and triangular. Tongue substance is well shown, as in the normal tomogram.



Figs. 8-11. Two cases of carcinoma of the maxillary sinus (Cases 4 and 5). The ordinary roentgenograms are shown above, the corresponding tomograms below.

Loss of visualization of the "H" and "R" lines does not represent invasion by cancer but rather an obscuring of these structures by overlying tumor and edematous soft tissue.

Figure 8 is the ordinary roentgenogram

of Case 4, a squamous carcinoma involving the right antrum in a man 50 years of age. There is a density within the right antrum which almost completely fills the chamber. The lateral and medial antral walls, however, appear intact, and the inferior wall of the sinus is obscured by bony structures in the same plane. There is no definite evidence of ethmoidal invasion, although some cloudiness is apparent within the cells. The orbital walls are intact.

The tomogram (Fig. 9) in this case, however, reveals a dense opacity completely clouding the right antrum. There is an area of bone destruction of the inferior antral wall and also of the lateral sinus wall. This cloudiness does not involve the orbit but extends superiorly and medially and to a small extent involves the middle ethmoidal air cells. The lateral and inferior walls of the right antrum are very thin, due to cancerous invasion and destruction. The nasal cavities show no abnormalities. There is a slight cloudiness of the lateral portion of the left antrum. Both orbits are well seen and still are spherical in outline, although rather small. The posterior ethmoids are clear. The "H" line is seen at the very base of the left antrum and the "R" line is well shown. Neither of these lines is well seen on the left side. The level of these films extends through the maxillary molar teeth bilaterally. The ascending rami of both mandibles are well delineated on this film, and the condyloid process is visible on the left side.

Figure 10 (Case 5) is an ordinary roentgenogram of a 47-year-old male who complained of right nasal blockage and pain in the right eye. The film discloses a moderate density involving the entire right antrum. There is a bulging soft-tissue mass obstructing the right naris, arising from the lateral wall of the nasal chamber, although there is no evidence of destruction of this medial antral wall. All the walls of the right antrum appear to be intact, and there is no evidence of inferior orbital wall destruction on either side. The ethmoidal sinuses are slightly clouded, and both medial and inferior turbinates are enlarged. Biopsy from the right maxillary sinus disclosed squamous carcinoma.

The tomogram (Fig. 11) in this case gives us much more detailed information. A dense opacity involves the medial half of the right antrum and indicates destruction of the right medial sinus wall. The process obstructs the superior portion of the nasal cavity and involves both the middle and posterior ethmoid cells. There is a suggestion of destruction of the inferior orbital wall on the affected side. Both orbits are well seen and the inferior turbinates appear slightly edematous. The left middle turbinate is clearly outlined and edematous, and only the inferior portion of the right middle turbinate is seen. The left antrum is intact and shows no evidence of abnormality. The tomogram is at the level of the molar teeth of the maxillae bilaterally, but no tongue substance is delineated. The "H" and "R" lines are not clear on this film.

These three cases of antral carcinoma reveal certain characteristic tomographic findings which are worth noting. It is also noteworthy that ordinary roentgenograms fail to picture the entire pathologic process which is so well delineated by tomographic means. Patients with antral carcinoma consult their physicians for one or more of three symptoms: nasal obstruction, visual disturbance, or pain. If these signs do not disappear under active medical therapy in a reasonable period of time, the patient should have tomographic studies and a biopsy if the roentgenograms suggest that carcinoma may be present.

As seen in the three cases, carcinomatous invasion and destruction of one or more of the antral walls is a frequent finding and may occur comparatively early in the disease. In most cases, the soft tissue tumor shadow extends beyond the antrum itself, through its osseous limits to adjacent structures, *i.e.*, naris, orbit, and oral cavity. It is only rarely that antral carcinoma is observed prior to osseous invasion or destruction and it is usually the symptoms caused subsequent to such de-

struction by the expanding mass of the tumor that force the patient to seek medical advice.

SUMMARY

Chronological adjacent tomograms through the levels of the mid-portion of the maxillary sinuses of an adult cadaver are presented, and the normal anatomical structures are described.

Comparison of these films is made with several tomograms disclosing infection and cancer in this area.

The tomograms in the cases of infections of the antrum disclose the following characteristics: (1) Pathologic disturbances in the limiting walls of the sinus are rare and the outline of both chambers is symmetrically alike. (2) Extension of the disease process to adjoining ethmoid sinuses is usually observed. (3) Edema of the contiguous turbinates and nasal mucosa is a constant finding.

Tomography in cancer of the antrum invariably discloses invasion and destruction of one or more of the walls of the sinus; also, the soft tissue shadow of the expanding tumor extends beyond the osseous limits of the sinus, invading adjacent structures, *i.e.*, naris, orbit, and oral cavity. Ethmoid sinus invasion is frequently seen.

Ordinary roentgenograms in cases of cancer of the maxillary sinus do not reveal these abnormalities so clearly or so fully as do tomographic films. The former frequently fail to disclose cancerous invasion of the limiting walls of the antrum.

It is the opinion of the authors that tomographic study is indicated in those cases in which clinical signs and ordinary roentgenograms suggest the presence of cancer in this area.

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Some Roentgen Aspects of Pancreatic Necrosis[1]

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THE CLINICAL diagnosis of acute pancreatitis is made rather infrequently; yet the diagnosis following surgical exploration is not uncommon. This wide discrepancy attests our lack of acumen in establishing a correct evaluation of those cases studied. Hence, any means that will provide a clearer understanding must command attention.

A large group of cases has been studied roentgenographically over a period of years, and various signs indicative of acute or subacute pancreatitis have been enumerated. These point predominantly to the changes induced in the gastro-intestinal tract, especially the stomach and duodenum. Case (1) in his excellent treatise on the subject reviews the changes that may be manifest, but it is evident that no one of these or any combination is diagnostic, nor will we, in this discussion, contribute any definitive set of criteria by which a positive roentgen diagnosis can be achieved. The case under discussion was, however, characterized by such striking roentgenographic findings that we feel they should be recorded.

One of the most significant reasons for the many incorrect diagnoses is the failure to think of the pancreas as the basis of abdominal complaints. A greater awareness of the organ as the exciting factor of abdominal symptoms will undoubtedly lead to closer scrutiny prior to exploratory laparotomy and contribute to more accurate diagnosis.

Bronner (2) suggests upper intestinal studies in any suspicious case, so that changes in the position, contour, and physiology of the stomach and duodenum may be demonstrated. Frostberg (3) attached considerable significance to the "inverted figure 3 sign" in changes within the head of the pancreas. We have encountered this particular sign infrequently, even though a number of cases of carcinoma of the pancreas were studied very carefully. We did, however, find it present in one instance, and on the strength of it, plus spasm of the duodenum, we proffered the diagnosis of pancreatitis. This was verified at operation.

In the case to be recorded here the signs and symptoms pointed so strongly to disease of the large intestine that no opaque material was given by mouth. Instead, a barium enema was considered the most logical procedure, after a film of the abdomen had been made. Unfortunately, the film failed to include the lung bases, so that we were deprived of the value of one finding that has been stressed—the basal exudates that often occur. The latter are mentioned by de Takáts and Mackenzie (4) and by Case (1) as an important part of the roentgen pattern in pancreatitis.

CASE REPORT WITH NECROPSY FINDINGS

W. E. S., a 42-year-old white married male, a cotton-mill worker, was admitted to the medical service for the first time on June 7, 1943, complaining of abdominal pain and distention of ten days' duration. He had previously been admitted to the surgical service, in January 1943, with a recurrent thrombophlebitis of the left leg, which was treated conservatively and successfully.

The illness for which the patient was admitted to the medical service had begun about ten days previously, at which time he experienced some vague abdominal discomfort and had an intense desire for large quantities of ice water and food. Shortly thereafter he noticed a rather diffuse abdominal swelling followed by generalized cramping abdominal pain, especially in the lower abdomen. This pain became severe and kept him moving constantly in an effort to obtain relief. He finally called his local physician, who gave him hypodermics, but the pain was only temporarily relieved. About twelve hours after the onset of symptoms, the patient became nauseated and vomited. The vomitus was greenish and bitter

[1] From the Departments of Radiology and Medicine, Duke University School of Medicine, Durham, N. C. Accepted for publication in October 1943.

and measured about a pint in quantity. On only two other occasions did vomiting occur before admission. The patient still had a desire for food, but had been afraid to eat because it seemed to accentuate the pain and distention. Belching was frequent and seemed to afford some relief. However, little or no flatus was passed and the patient stated that he had not had a bowel movement during the ten days of his illness. His last normal bowel movement was on the day prior to the onset of symptoms. He was given repeated enemas in his home and also at a local hospital, but without results; nor did they afford him any relief. A note from a local physician stated that the patient had had several episodes of this character during the previous two or three years, but in the review of symptoms and past history obtained at the hospital in January, six months before the patient's final illness, no mention of such attacks was made.

The family history was positive for cancer, diabetes, and tuberculosis. The patient had enjoyed unusually good health with the exception of the thrombophlebitis mentioned above. He said that he had lost approximately twenty pounds during his illness.

Physical Examination: The patient was well developed and well nourished and obviously acutely ill. His temperature was 38.2° C., pulse 122, respirations 24, blood pressure 126/84. During the examination he complained constantly of abdominal pain and was made quite uncomfortable by any effort to move him. Except for evidence of dehydration, the skin was not remarkable. Examination of the head and neck was negative. The thorax was symmetrical, but there was some flare of the lower costal angles, apparently due to abdominal distention. The lung fields were clear to auscultation and percussion, but the diaphragm was somewhat high. Examination of the heart was within normal limits except for tachycardia. The abdomen was rounded and protuberant, and the abdominal wall was tense and tympanitic. There was generalized tenderness in all abdominal quadrants and moderate rebound tenderness in both lower quadrants. It was thought, in spite of the marked distention, that the liver was considerably enlarged, but no other visceral detail could be outlined and no abnormal masses were felt. The superficial veins of the abdominal wall stood out in striking prominence. Large hard masses of feces could be felt by rectal examination. The genitalia were not remarkable. Examination of the extremities revealed no evidence of clubbing, cyanosis, edema, or phlebitis. Neurological examination was in order.

Preliminary Clinical Impression: 1. Obstruction of the large bowel. 2. Portal obstruction, possibly on the basis of cirrhosis of liver.

Accessory clinical data were as follows: Hemoglobin 11.3 gm., or 73 per cent. Red blood cells 4,410,000. Color index 0.82. Hematocrit reading 38.2 vols. per cent. White cells 12,280 (polymorphonuclears 94, large lymphocytes 1, small lymphocytes 2, monocytes 3). Sedimentation rate 36 mm./hr. corrected. Urine, on admission, clear amber; sp. gr. 1.016; acid reaction; sugar a trace; albumin 1 +; microscopic sediment, 3–4 granular casts, 6–7 white blood cells (?) per high-power field; acetone 4 + ; diacetic acid negative. Kahn and Klein tests negative. Stools not remarkable except for 1 + benzidine reaction after ether extraction. Blood chemistry: non-protein nitrogen 44 mg. per 100 c.c. Liver function test (BSP): 5 per cent retention of dye after one hour. Galactose tolerance test within normal limits.

Roentgen Findings: A plain film of the abdomen showed no definitive visceral detail, but there was present a mottled process characterized by irregular rounded areas of increased density. These areas ranged from 1.0 to 3.0 cm. in diameter and showed no calcification. A film with a stomach tube in place showed the tube deflected well to the right and upward.

A barium enema study revealed areas of spasm associated with loss of normal mucosal detail. These areas were in the mid-transverse colon, the splenic flexure, and the ileocecal region. There was no evidence that any intrinsic lesion was present.

Hospital Course: The patient was given nothing by mouth and parenteral administration of fluids was begun. A Wangensteen apparatus was installed and surgical consultation was obtained immediately. The surgical consultant expressed the belief that the patient had a fecal impaction and advised thorough cleansing of the lower bowel with repeated enemas, before anything else was done. This was carried out with good results and considerable relief to the patient. He had a fairly good first night in the hospital, and the next morning it was thought that there was less abdominal distention. The liver was palpable about 2 cm. below the right costal margin, but no other masses could be made out. At this time a barium enema was given and the results were as recorded above. The patient remained fairly comfortable throughout the next twenty-four hours, without any temperature elevation. On the night of the second hospital day he had a normal bowel movement. He awoke on the third hospital morning complaining of generalized increase in abdominal pain, which seemed to become progressively worse from that time. The abdominal distention returned but there was still no nausea or vomiting; there was generalized abdominal tenderness with rebound tenderness in all quadrants, but there were no referred rebound phenomena. No intestinal patterns could be made out. For the next two days the patient gradually grew worse, his temperature going to 39° and his pulse to 140. On the sixth hospital day abdominal tenderness and distention increased and, because of signs consistent with the presence of free fluid in the peritoneal cavity, an abdominal paracentesis was performed. Only 2 c.c. of dark amber fluid were obtained, but

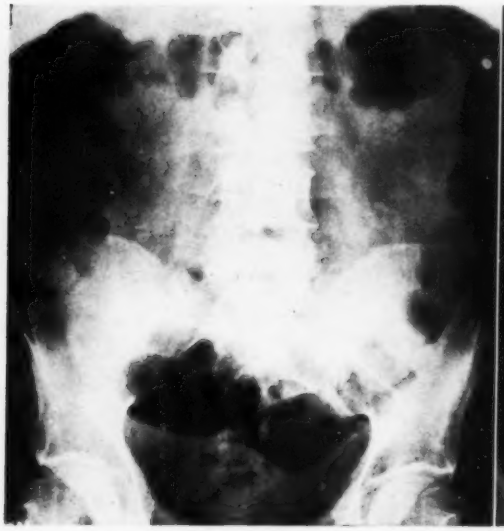

Fig. 1. Film of abdomen showing diffuse mottled appearance. The gas-filled colon shows irregularity about the cecum and the transverse colon.

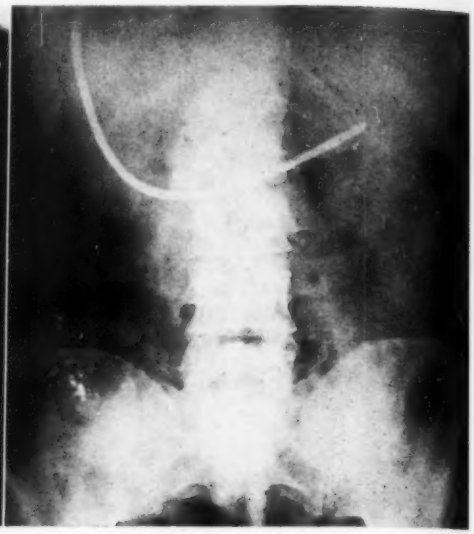

Fig. 2. The striking displacement of the stomach tube is evident, as well as the diffuse mottling over the abdomen.

this material showed a total leukocyte count of 1,120, with 61 per cent polymorphonuclear forms, and gave a strongly positive benzidine reaction. Culture of this fluid was later reported as negative. A few hours later, the patient presented the picture of peripheral vascular collapse, and after transfusions of whole blood and plasma it was decided to do an exploratory laparotomy.

The patient was obviously a poor operative risk, but there seemed to be no alternative. He was given gas, oxygen, and ether anesthesia, which he took poorly. When the extraperitoneal fat layer was reached, extensive areas of fat necrosis were encountered. In the peritoneal cavity, a moderate amount of blood-tinged fluid was found and aspirated. Manual exploration of the abdominal cavity revealed a large, firm mass in the region of the pancreas, extending all the way across the upper abdomen and measuring approximately 10 × 20 cm. The omentum, peritoneum, mesentery, and intestinal surfaces were studded with numerous areas of firm white material which resembled fat necrosis. No purulent material could be aspirated from the pancreas. The incision was closed after drains were inserted and the patient was returned to the ward in poor condition.

The postoperative course was stormy. The temperature remained above 40° and there was continuous vomiting of "coffee-ground" material. On the third postoperative day the patient vomited about 500 c.c. of fresh blood. He died on the following day.

Accessory data obtained throughout the postoperative course were as follows: Hemoglobin 68 per cent. White blood cells 13,640. Blood sugar 110 mg. per cent. Van den Bergh reaction not elevated. Serum calcium 6.8 mg. per cent. Urinary diastase less than 150 units. Serum lipase 2.3 c.c. NaOH (1/20th normal).

Autopsy Findings: The external appearance of the body at autopsy was not particularly significant. There was pitting edema of the entire left leg, but not of the right.

Examination of the abdominal cavity was quite remarkable. The subcutaneous fat of the abdominal wall measured 1.5 cm. in thickness. In the abdominal cavity about 400 c.c. of grayish-brown fecal-smelling fluid were encountered. After removing the fluid the intestines were found to be everywhere adherent along their adjacent peritoneal surfaces. Scattered diffusely throughout the parietal peritoneum were numerous flat, whitish-yellow, firm nodules. These were present also in the peritoneal surfaces of the intestines, in the mesentery, and throughout the omentum. Many of these plaques were surrounded by areas of fresh hemorrhage. The remaining peritoneal surfaces were cloudy but smooth. The transverse colon and stomach were shifted to abnormal positions by the lesser omental bursa, which was distended with fluid, the colon being pushed anteriorly and inferiorly, the stomach superiorly and to the right. The foramen of Winslow was closed by a grayish, dark mottled membranous adhesion with a small defect at one side. Pressure over the bursa forced out a grayish-brown, foul-smelling fluid containing many small soapy granules. Numerous fibrous adhesions were found in the pelvis, which also contained the yellowish-white

plaques. Sectioning of the plaques showed them to be firm but not calcified. Many extended deeply into the fatty areas; some had formed large confluent areas, while others were necrotic and milky.

The mesentery was greatly increased in size and loaded down with fat. Large redundant folds of fat were found throughout the mesentery of the large bowel. Everywhere were yellowish-white plaques of fat necrosis, many surrounded by hemorrhage.

As stated above, the stomach was pushed upward and to the right by the fluid-distended omental bursa. The position, size, and shape of the stomach were greatly distorted and undoubtedly accounted for the anatomical relations demonstrated roentgenologically. The stomach contained about 100 c.c. of coffee-ground material and near the cardiac end was an area of mucosal hemorrhage which apparently accounted for the blood vomited postoperatively.

The pancreas was identified in its usual position as a large, ragged, grayish-black, necrotic mass, forming one border of the fluid-filled sac. Gross sectioning showed the inner structure to be obscured by areas of necrotic softening and hemorrhage. The main pancreatic duct opened about 3 cm. from the duodenum into the omental cavity already described. The ampulla of Vater was patent, as were the common, cystic, and liver bile ducts. These were not dilated. No calculi were found.

The gallbladder contained about 10 c.c. of dark, thick, orange-colored bile, but no calculi were found. The gallbladder wall was considerably thickened both by serosal fibrosis and mucosal cholesterosis. The liver was moderately enlarged, weighing 1,500 gm. Its cut surface gave the appearance of increased fat. The adrenals and genito-urinary tract were not grossly remarkable.

The pleural cavities contained small amounts of serosanguineous fluid, but the pleural surfaces were smooth. The subpleural fat contained many areas of hemorrhagic fat necrosis, most of which were perivascular in position. The heart was normal in size and appearance. The coronary arteries were not remarkable. The lungs on cut surface showed evidence of some bronchial pneumonia.

Microscopic sections were equally as characteristic of an acute hemorrhagic pancreatitis as the gross manifestations. The pancreas presented a pronounced degree of atrophy, marked dilatation of the ducts, and an accompanying hyperplasia and keratinization of the duct epithelium. In some places, the latter lesion was of such a nature as to obstruct completely the lumen of the duct. Although hemorrhage was prominent, the necrosis of the tissue was a far more conspicuous feature. Fat necrosis was present in numerous places and crystallization of the fatty acids was also seen in some of these lesions. There were, however, no calcium deposits in these areas of fat necrosis.

The gallbladder showed a very definite chronic cholecystitis and also acute reaction of its serosal surface. There was an overwhelming infection of the tissues of the body generally, the most conspicuous organism being *E. coli*. This organism was grown in cultures taken from the spleen, lung, and peritoneal fluid at the time of autopsy.

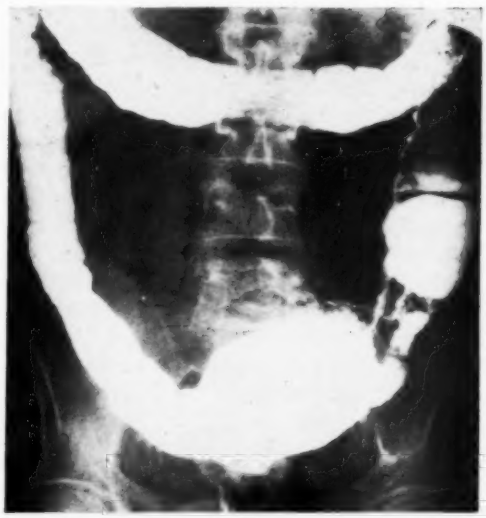

Fig. 3. Showing changes at the medial wall of the splenic flexure of the mid-transverse colon and also at the ileocecal region.

DISCUSSION

The roentgen findings were interesting and permitted considerable speculative latitude as to the underlying condition. An appreciation of the extensive changes that occur with fat necrosis incident to pancreatitis led to the assumption that the mottled areas of increased density actually represented fat necrosis and subsequent saponification, which is so characteristic pathologically (Fig. 1).

The marked displacement of the stomach to the right and upward (Fig. 2), we interpreted as due either to swelling of the pancreas and surrounding inflammatory tissue or a sealing-off of the foramen of Winslow with subsequent accumulation of fluid within the lesser omental bursa.

The barium enema revealed three zones (Fig. 3) of disturbance in the colon. There was persistent spasm with alteration of the mucosal pattern of the transverse colon and the splenic flexure. The close

anatomical relationship between the pancreas and the involved areas of the colon made it reasonable to assume that pancreatic involvement was the source of these changes. The enema film likewise showed marked changes about the cecum and terminal ileum and these were deemed as secondary to the fat necrosis and the incident peri-intestinal inflammation.

All the changes described may, of course, be readily explained on the basis of a peritonitis pursuant to a ruptured viscus. The absence of any free air in the abdomen was against such a diagnosis; moreover, an appraisal of the clinical course made it the less likely condition.

CONCLUSIONS

A case of hemorrhagic pancreatitis with extensive fat necrosis is presented. The roentgen features were: (1) a mottled increase in density over the abdomen; (2) displacement of the stomach to the right and upward; (3) areas of spasm in the mid-transverse colon, the splenic flexure, and the ileocecal region.

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Reciprocity Law Failure in X-Ray Films[1]

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THE RECIPROCITY law constitutes one of the fundamental rules of photography and of radiography. It states that the quality of a series of photographic or radiographic films will be uniformly constant if the exposure times with which the films are made vary reciprocally with the intensities of the exposing radiation. Thus, the law implies that when other things are equal a roentgenogram exposed for 1.0 second and with a tube-current of 100 milliamperes will be identical to one exposed for 10 seconds and with a tube-current of 10 milliamperes.[2]

The reciprocity law is based on the assumption that the density or blackening of a photographic film is dependent merely on the exposure or quantity of radiant energy which the film absorbs and is independent of the rate at which the energy is applied (*i.e.*, is independent of the intensity of the exposing radiation). The significance of this assumption will be clearly understood when it is pointed out that the exposure or quantity of radiant energy absorbed by a film is equal to the product of the radiation's intensity by the exposure time; that is,

$$Exposure = Intensity \times Time \qquad (1)$$

It is evident from equation (1) that, when intensity and time vary reciprocally, exposure remains constant. Therefore, the reciprocity law can be valid only when photographic density is dependent on exposure alone.

The reciprocity law was formulated from observations made by Bunsen and Roscoe (1) almost a century ago, when those workers were studying the phenomena of photochemistry. Although the law was intended to apply to photochemical reactions in general, it had, from the outset, its principal application in photography, where it was used extensively as an aid in the calculation of exposure technics. Its usefulness in this connection, however, was soon found to be somewhat limited, for further investigations revealed that photographic films fulfill the law only under limited conditions. For example, astronomers (2, 3), when photographing stellar objects of extremely low illumination, observed that much smaller photographic effects were obtained under these conditions than when exposures were made with higher intensities, even though the products of intensity by exposure time in the two instances were equal. Similarly, it was observed by other investigators (4, 5) that, when exposures were made with radiation of extremely high intensity, the effects were less than those obtained when a more intermediate level of intensity was employed. It is clear from these observations that, contrary to the provisions set forth in the reciprocity law, photographic quality is not merely dependent on the quantity of radiant energy absorbed by a film, but is also a function of the intensity of the exposing radiation. This property of photographic materials to violate the reciprocity law is customarily spoken of as reciprocity law failure.

The principal significance of reciprocity law failure is its effect on the sensitivity or speed of a photographic emulsion. Because more radiant energy is required to produce a particular photographic effect at some intensity levels than at others, it is evident that the sensitivity or speed of a film must vary with the intensity of the exposing radiation.

[1] The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Chicago. Accepted for publication in November 1943.

[2] It is assumed that the intensity of the radiation is proportional to the current of the x-ray tube.

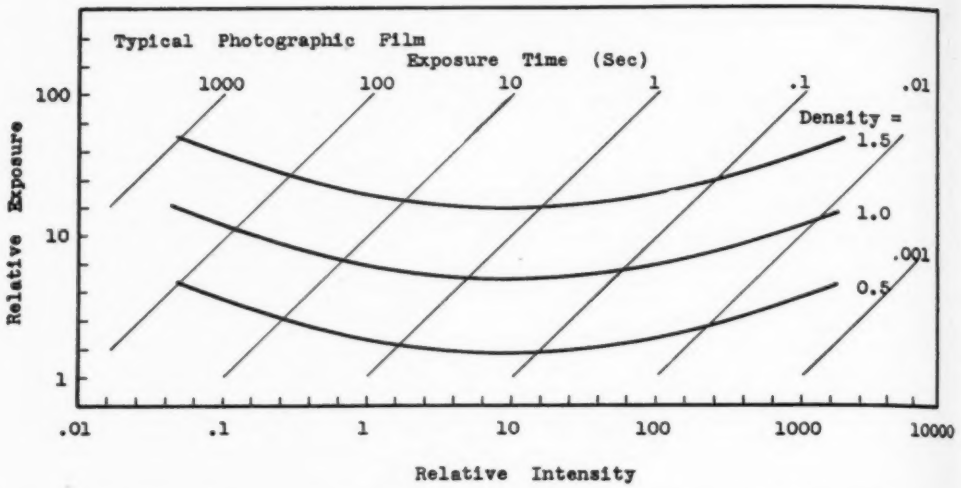

Fig. 1. Curves illustrating reciprocity law failure in a typical photographic film. The exposures required to produce film densities of 0.5, 1.0, and 1.5 at various levels of intensity are shown. The diagonal lines indicate the exposure times which correspond to the various intensity levels.

Although photographic films vary widely in the manner in which they fail the reciprocity law, there are certain general characteristics that are common to all:

1. Photographic emulsions are least sensitive when exposed with radiation of either low or high intensity and are most sensitive when the intensity of the exposing radiation is such that an exposure time between 0.1 second and 10 seconds is required to produce a film density of 1.0 (6, 7).

2. Within the visible spectrum, reciprocity law failure is independent of the spectral distribution of the exposing radiation (8).

3. The inherent contrast of a photographic emulsion is a function of reciprocity law failure. It is greatest when exposures are made with intensities less than that at which maximum film sensitivity occurs (9).

METHODS OF STUDYING RECIPROCITY FAILURE

During the past several decades extensive data have been collected on the reciprocity-law-failure characteristics of many photographic films, and several workers (3, 7, 10) have devised empirical formulae intended to be useful in predicting the density (photographic effect) of a film when exposed with a particular quantity of radiant energy at various intensity levels. These formulae, however, have proved of little practical value, due to the wide variation in the characteristics of different photographic materials. Of greater usefulness are graphical data prepared from sensitometric examinations of a film exposed under various conditions of illumination. In the past, three methods have been employed in the preparation of such material. In one, the photographic film is given a series of constant-energy exposures in which the intensity and exposure time are varied reciprocally (*e.g.*, $I \times t = 100 \times 1, 10 \times 10, 1 \times 100$, etc.). The film is processed and the several densities are measured. Density is then plotted against intensity of exposing radiation. Another method, proposed by Arens and Eggert (11), consists in determining sensitometrically the exposure times required to produce a particular film density (*e.g.*, a density = 1.0) at various intensity levels. Exposure time is then plotted as a function of radiation intensity. In the third method, suggested by Kron (7) and

later expanded by Jones and Webb (9), the exposures ($I \times t$) required to produce a constant density are determined sensitometrically under various intensity conditions. As in the other methods, results are expressed in graphic form.

A family of curves obtained by the third method and illustrating the exposures required to produce three different densities in a typical photographic film at various levels of intensity are shown in Figure 1. If the reciprocity law were valid, these curves would be horizontal straight lines, since fulfillment of the law implies that the blackening of a film is independent of the intensity of the exposing radiation. That they are not is graphic evidence of the existence of reciprocity law failure. The general shape of these curves is characteristic of all photographic emulsions when exposed with radiation within the visible spectrum. It will be observed that there is one intensity level at which a minimal amount of exposure is required to produce a particular density. This intensity is frequently called the optimal intensity, or the intensity of maximum film sensitivity. Its value changes from one emulsion to another but, as previously stated, it usually is such that the exposure time required to produce a density of 1.0 falls between 0.1 and 10 seconds. The diagonal lines in Figure 1 indicate the exposure times which correspond to the various intensity levels.

Much useful information, including the speed, contrast, and other characteristics of a film, may be obtained from curves similar to these. For example, the speed or sensitivity of a radiographic film is customarily derived from the equation,

$$s_s = \frac{d}{E_{1.0}} \qquad (2)$$

where s_s is the speed of the film, $E_{1.0}$ is the exposure($I \times t$) required to produce a film density of 1.0, and d is an arbitrary constant of such magnitude that the various values of s_s fall within a convenient range of numbers. The values of $E_{1.0}$ may be determined directly from the experimental curves.

RECIPROCITY LAW FAILURE IN X-RAY FILM

Although photographic materials have been thoroughly investigated for reciprocity law failure, relatively few studies have been made on radiographic film, for reasons that will presently become apparent.

The sensitivity of a photosensitive emulsion is a function of the quality of the exposing radiation. Accordingly, when a film is investigated for reciprocity law failure, either the intensity of the exposing radiation must be recorded by an intensitometer whose spectral sensitivity is identical with that of the film under test, or the quality of the radiation must be maintained constant through the complete range of intensity studied. Until recently no x-ray intensitometer fulfilled the first criterion, and except under limited conditions it is most difficult to fulfill the second. If the intensity is varied by changing the target-film distance, the filtration of the intervening air may cause significant changes in x-ray quality. Also, if intensity is regulated by changes in the milliamperage applied to the x-ray tube, alteration in the wave-form of the potential produced by the x-ray transformer-rectifier system will be sufficient to cause important changes in quality unless a constant-potential machine is employed.

In spite of these difficulties, limited studies[3] of reciprocity law failure in films exposed to x-rays directly have been conducted by several workers (12–17). All reached the conclusion that emulsions exposed in this manner fulfill the reciprocity law. These observations have been supported by Holthusen and Hamann (18) and by Rosenberger, and Goldhaber (19), who studied reciprocity law failure in films exposed with gamma radi-

[3] As early as 1899, Precht (12) observed that films exposed with x-rays do not behave as films exposed with light. It was not until later, however, that organized studies of this phenomenon were instituted. The first quantitative data to indicate that films exposed with x-rays directly obey the reciprocity law were reported by Kroncke (13), whose observations were carried out through an intensity range of one to four. Later investigations expanded the range to over one to one hundred.

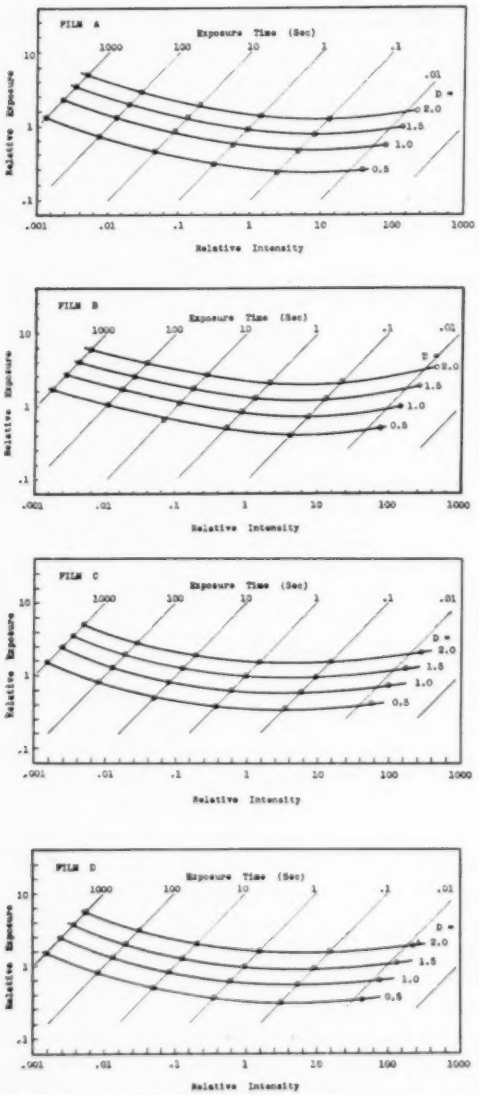

Fig. 2. Curves illustrating reciprocity law failure in four brands of x-ray film exposed with intensifying screens.

ation; in these latter investigations, no failure was observed through a range of intensity exceeding one to ten thousand.

As far as can be determined, no studies have been made on the reciprocity-law-failure characteristics of films exposed with intensifying screens. Since 90 to 98 per cent of the density in such films is produced by fluorescent radiation in the visible spectrum, it is reasonable to expect that they will exhibit characteristics similar to those of photographic emulsions.

The major difficulties involved in the study of reciprocity law failure in radiographic film have recently been overcome by the development of an x-ray intensitometer (20) whose spectral sensitivity may be made to parallel those of films exposed either with or without intensifying screens through an extensive range of x-ray quality.[4] With the aid of this instrument, the reciprocity-law-failure characteristics of four brands of radiographic film exposed with and without intensifying screens have been investigated in this laboratory.

In the investigation the films were examined sensitometrically by the aluminum-ladder method proposed by White (21). In the case of the exposures made with intensifying screens, the range of intensity studied was one to one hundred thousand; the range of intensity employed in the exposures made with x-rays directly was one to ten thousand. Radiation was supplied by a four-valve full-wave (60-cycle) generator for exposures of ten seconds or less, while a generator utilizing a Villard circuit provided the radiation for the exposures of longer duration. Radiation intensity was measured by the x-ray intensitometer referred to above, but modified to operate as an integrating device to facilitate its use when exposure times were less than one second. The half-value layer of the radiation employed in the intensifying screen exposures was held constant within ± 10 per cent, in order to maintain the relative contributions to film blackening by the front and back intensifying screens constant throughout the investigation. This was done to insure that the shape of the films' sensi-

[4] Strictly speaking, the spectral response of this intensitometer does not coincide with that of any radiographic film. When the exposing radiation is heterogeneous, however, the instrument's response has been found to parallel that of films exposed either with or without intensifying screens through a wide range of x-ray quality when the proper adjustments are made. Thus the intensitometer effectively fulfills the criterion that its spectral response be identical to that of the film under test.

tometric curves be consistently uniform. The various films were processed under identical conditions in a pictol-hydroquinone developer and finally were subjected to densitometric examination.

It is well established that reciprocity law failure is affected to a considerable degree by changes in room temperature (22). During the investigation, the temperature of the exposing room remained within ±3° of 25° C., a variation that is not likely to cause significant error in the experimental results.

The results of the investigation are shown graphically in Figures 2 and 3, in which the exposures required to produce densities of 0.5, 1.0, 1.5, and 2.0 in each of the four brands of film are plotted as a function of the intensity of the exposing radiation. For Figure 2, exposures were made with intensifying screens, whereas, for Figure 3, the films were exposed to roentgen rays directly. The diagonal lines indicate the exposure times employed at the various intensity levels. All of the films from which the data recorded in Figure 2 were derived were exposed with Eastman ultra-speed intensifying screens. Curves, identical in form, were obtained with other brands of screens; in each case, however, the curves were displaced in a direction parallel to the exposure-time diagonals, a distance depending on the screen's intensification factor.

It is interesting to observe that the curves of the films exposed with intensifying screens (Figure 2) are similar in form to those of the photographic film illustrated in Figure 1. This clearly indicates that films exposed in this manner fail the reciprocity law in much the same way as do photographic materials. As previously pointed out, this is as one would expect, for almost all of the blackening in films exposed in this manner is produced by fluorescent radiation falling within the visible spectrum.

Films exposed with x-rays directly behave in a remarkably different manner. Since the curves, illustrated in Figure 3, are horizontal straight lines, it is evident

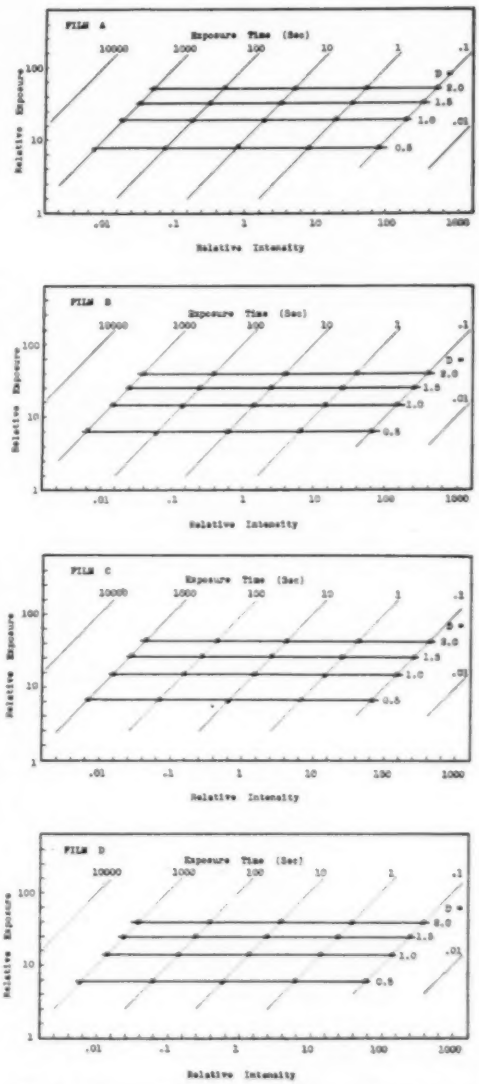

Fig. 3. Curves illustrating absence of reciprocity law failure in four brands of x-ray film when exposed with x-rays directly.

that such films fulfill the reciprocity law completely. The significance of this phenomenon will be discussed later.

SIGNIFICANCE OF RECIPROCITY LAW FAILURE

Reciprocity law failure is of considerable importance in several phases of radiography. As previously stated, the speed of a film which exhibits reciprocity law

failure is dependent on the intensity of the radiation with which it is exposed. Thus, a film employed in radiography of the chest, where the intensity of the exposing radiation is relatively high, will have a different speed rating than the same film when used in the examination of the pelvis, where the intensity of the incident radiation is considerably lower. Most radiologists are unaware of this phenomenon, since a film's speed factor does not usually enter directly in the calculation of radiographic exposure technics. Nevertheless, suitable compensation must be made for it, either knowingly or unknowingly, in the preparation of every chart expressing radiographic technical factors, if the chart is to be satisfactory.

Since each film which fails the reciprocity law does so in a manner different from that of any other, it follows that one film may be faster than another at one intensity level, yet slower than the other at another intensity level. This is well shown in Figure 4, where the speeds of the four films whose characteristics are illustrated in Figure 2 are plotted through a considerable range of intensity; the various values were calculated from equation (2). The vertical dotted line indicates the intensity at which an exposure of one second will produce in film C a density of 1.0; a large number of radiographic examinations are done near this intensity level. It will be observed that, when the relative intensity is 10 (approximately that used in chest radiography), film A is considerably faster than film C; yet when the relative intensity is 0.1 (that frequently encountered in the examination of the lateral lumbar spine), film C is the faster. This explains an observation frequently made by radiologists that one brand of film seems preferable to all others for some procedures, while the results obtained with another are more satisfactory under different circumstances. When testing the merits of a new brand of film, it is wise to make roentgenograms of a wide variety of anatomical structures before passing final judgment.

The existence of reciprocity law failure in films exposed with intensifying screens and the lack of such failure in films exposed to x-rays directly are of great importance in industrial radiography. When objects of high atomic number (steel, etc.) are examined, exposures routinely are many minutes in length, and not infrequently exceed several hours. An examination of Figures 2 and 3 reveals that at these low intensities and correspondingly long exposure times, the speeds of films exposed with intensifying screens will not differ significantly from those of films exposed directly to x-radiation. This is one of the reasons why intensifying screens are not widely used in industrial radiography.

Those who use radiographic film for photometric purposes (for the radiographic determination of x-ray intensities) must consider reciprocity law failure when exposures are made with intensifying screens. Failure to do so will obviously introduce sizable errors in the calculated results.

Reciprocity law failure must also be given careful consideration in the design and calibration of radiographic exposure meters (20) and automatic timers (23). It is not possible, however, to discuss this phase of the subject at this time, since restrictions of secrecy imposed by the armed services, for whom these devices are under development, prohibit the disclosure of the methods which have been devised to compensate for the phenomenon.

THEORETICAL CONSIDERATIONS

Although the phenomenon of reciprocity law failure has been recognized almost from the beginning of photography, it has been only within the last few years that some of its underlying causes have been understood. This recent clarification of the subject has been largely effected through experimental investigation and the application of the principles of atomic physics to photographic theory. Before pursuing a discussion of the etiology of reciprocity law failure, however, we should pause briefly to review some of the basic prin-

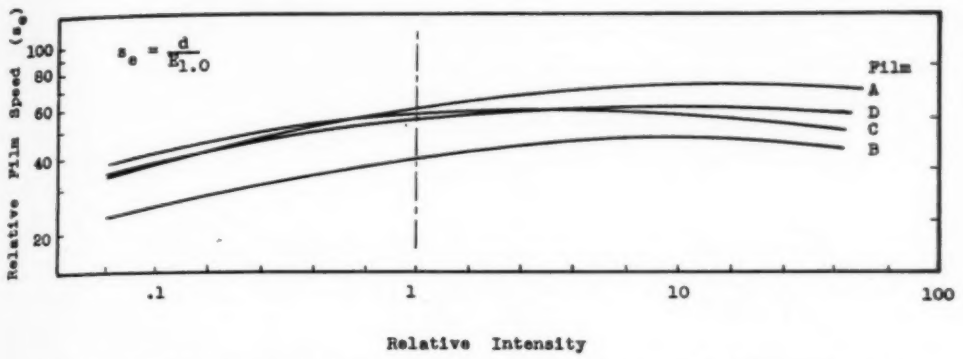

Fig. 4. Speeds of four brands of x-ray film exposed with intensifying screens at various intensity levels.

ciples of the photographic process. Only in this way can a clear understanding of the subject be gained.

Fundamentally, a photographic emulsion consists of a suspension of microscopic crystals of silver halide (principally silver bromide) in gelatin. Also included are minute amounts of silver sulfide concentrated at discrete points over the surfaces of the crystals, and serving as sensitivity-promoting agents. When light or x-rays impinge on the emulsion, some of the crystals are altered in such a manner that they can be reduced to metallic silver by certain reducing agents called developers. The mechanism whereby the crystals are converted into a developable state by the action of radiant energy has been the subject of considerable speculation. Of the many theories which have been suggested, that proposed by Sheppard, Trivelli, and Loveland (24) and recently amplified by Gurney and Mott (25) seems most satisfactory. It is supported by considerable experimental evidence and is in good accord with modern concepts of atomic physics. This theory suggests that when a silver bromide crystal absorbs a quantum of radiant energy, the energy of one of its electrons is raised to a state wherein the electron enters the conduction band of silver bromide and thereby may move freely through the crystal lattice. When thus excited, the electron may follow one of several courses. It may liberate its energy immediately, recombine with its parent atom, and return the crystal to its original state. Another possibility is for the electron to migrate from the silver bromide crystal to one of the silver sulfide specks. Since the energy level of the conduction band of silver bromide is higher than that of silver sulfide, the electron will give up some of its energy in the process. Accordingly, once the electron is within the conduction band of silver sulfide, it will be trapped there, since it will have insufficient energy to return to the silver bromide crystal.

When an electron is trapped in this manner, the silver sulfide speck becomes negatively charged. This causes a positively charged silver ion to migrate from the bromide crystal to the speck, there to neutralize the charge and be converted to metallic silver. As the exposure of the crystal continues, additional silver will be deposited at the speck and also at the numerous other specks over the surface of the crystal. These submicroscopic foci of silver form nuclei around which the remaining silver of the crystal can be deposited by the action of the developer. Without such nuclei the crystal is not developable.

The theory just outlined appears to be fundamentally sound. As previously pointed out, it is founded on well accepted concepts of atomic physics and is supported by much experimental evidence. Because of limitation of space, none of this evidence has been cited. The publications of Webb

(26) and of Mees (27) furnish excellent reviews of this material.

The Gurney-Mott theory provides for the first time a simple and reasonable explanation of reciprocity law failure. Two factors, one operating at high intensity levels and the other at low intensity levels, are probably responsible for the phenomenon (26). When a photographic emulsion is exposed with radiation of high intensity, large numbers of electrons in the silver bromide crystals will be raised to an excited state within a short interval of time. Some of these electrons will be trapped by the silver sulfide specks and create an electrostatic field which prevents the trapping of additional electrons until the field is neutralized by the migration of silver ions from the crystal. While this migration is taking place, the untrapped electrons will be repelled by the electrostatic field and be driven far afield to be lost to the photographic process. The number of electrons lost in this manner will depend on the rate of electron excitation by the photographic exposure and on the speed of migration of the silver ions. Obviously, the number will become greater as the intensity of the exposing radiation increases. This loss of available electrons causes a diminution in photographic efficiency and, accordingly, the amount of radiant energy required to produce a particular photographic effect becomes progressively greater as the intensity of the exposing radiation increases.

At low intensity levels, loss of film sensitivity may be traced to another cause. There is excellent experimental evidence (25) to show that the submicroscopic foci of silver deposited at the silver sulfide specks are extremely unstable in their early stages of formation and tend to disintegrate readily. If the rate of formation is slow, as is the case when the intensity of the exposing radiation is low, many of the foci may disintegrate before they reach a stable state. Such foci obviously will be lost to the photographic process and a diminution of emulsion sensitivity thereby will result.

These concepts of reciprocity law failure have received considerable support from the experimental studies of Webb (26), and there seems to be good reason to believe that they represent a fairly accurate picture of the mechanism of the phenomenon.

Although the preceding discussion has indicated the probable causes of reciprocity law failure in films exposed with visible light, it has not explained the lack of reciprocity law failure in films exposed with x-radiation directly. As we shall see presently, however, the Gurney-Mott theory may be extended to provide a satisfactory explanation of this phenomenon. When x-radiation falls on a photographic emulsion, high-velocity photoelectrons are liberated. In dissipating their energy, these photoelectrons produce, by interaction with the crystal within which they are located, clouds of low-velocity secondary electrons, the number of which may exceed the number of primary photoelectrons by many thousands of times. The secondary electrons behave similarly to electrons excited by light; that is, some are trapped by silver sulfide specks and contribute to the photographic process. Now the number of secondary electrons produced by each photoelectron is not dependent on the intensity of the x-radiation, but merely on the energy of the quantum absorbed. Furthermore, it is reasonable to assume that when a crystal absorbs one quantum of radiant energy there are sufficient secondary electrons produced to cause the crystal to be converted into a developable state. Thus, the photographic process in emulsions exposed to x-radiation directly is entirely independent of the intensity of the exposing radiation. This being the case, one should expect the reciprocity law to be fulfilled completely by films exposed in this manner.

Further support of these theories may be found in the density *vs.* exposure curves of films exposed with light (or with intensifying screens) and of films exposed directly to x-rays. It is well known that films exposed with light exhibit disproportion-

ately low responses when exposures are small (this characteristic is frequently called photographic inertia), whereas films exposed with x-rays do not. This is just as it should be if the Gurney-Mott theory is valid, for when exposures are small and made with light, many of the silver foci deposited at the silver sulfide specks are likely to be immature. As pointed out above, such foci tend to disintegrate readily and become lost to the photographic process, thereby causing a diminished photographic effect. When exposures are made with x-rays, on the other hand, the absorption of each quantum of radiant energy results in the production of such large numbers of secondary electrons that a stable silver focus is always assured. Therefore, the efficiency of the photographic process under these conditions is not reduced.

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Supervoltage Roentgen Therapy of Esophageal Carcinoma[1]

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THIS DISCUSSION will be limited to a consideration of radiation therapy of epidermoid carcinomas of the thoracic portion of the esophagus. Carcinomas of the upper third, as well as adenocarcinomas of the lower third, are excluded, as they present a different therapeutic problem, and everywhere in cancer therapy progress has been hastened by the recognition of the different types of tumors which may occur in a particular organ.

Carcinomas of the upper third or cervical portion of the esophagus are biologically, therapeutically, and prognostically to be considered in the same group as hypopharyngeal carcinomas. While technical advancements may still improve their curability, we feel that the principles of treatment here are established. For these carcinomas 200-kv. radiation offers today an approximate mean curability of 20 per cent. While this figure may eventually be improved by better technic and the application of higher voltage, we do not believe that the latter *per se* offers a fundamentally new approach.

The main reasons for the better results in tumors of the cervical, as compared with those in the thoracic esophagus, are probably their earlier recognition and their location, which permits the application of a sterilizing dose into the tumor with radiation of medium voltage.

The exclusion of the glandular carcinomas of the lower third of the esophagus does not mean that these tumors are not responsive to irradiation. Some of the polypoid adenocarcinomas of the cardia are quite radiosensitive, and a number of cases treated by others (Merritt) and by ourselves have shown definite improvement under radiation therapy, as evidenced by the patient's general condition, temporary disappearance of the tumor as shown roentgenographically, and a change in the gastroscopic picture. These tumors are, however, biologically different from the epidermoid carcinomas and in the interests of clarity it seemed wiser to eliminate them.

Treatment of carcinoma of the thoracic portion of the esophagus is still an unsolved problem. Although the number of apparent surgical cures has increased with the improvement of thoracic surgery during the last decade, the procedure is so formidable, and the prognosis in the individual case so unpredictable, that operation cannot be considered a solution. The local application of radium—intracavitary or interstitial—has universally failed; with the exception of Guisez, no one has reported any cures. This procedure has been discarded by more experienced observers because of the unsatisfactory results and the danger of acute perforation (Zuppinger).

Two hundred-kilovolt roentgen therapy of these esophageal cancers is the only radiologic approach which, so far, has given sufficiently uniform palliative results to warrant its consideration as a clinical procedure with definite indications and contraindications. Reports of larger series treated consistently by this method, as well as our own experience, demonstrate that in about one-half of the patients the tumor shows sufficient response to overcome the obstruction and thus outweigh the disadvantages of the rather formidable course of therapy. In these cases it is possible to avoid a gastrostomy and the patients usually remain in good condition six to eighteen months after treatment. Most of them die not of starvation but from perforation into the trachea or bronchi, with rapidly progressing aspiration

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pneumonia. Zuppinger, in 161 cases, obtained a regression of the tumor with improvement of the stenosis in 79, or almost 50 per cent. Twenty-one cases remained stationary and 61 showed no improvement, but in most of this latter group treatment had to be discontinued for one reason or another. Strandqvist obtained primary freedom from symptoms in three-fourths of 36 cases treated with 180-kv. radiation.

We believe that 200-kv. radiation therapy, which now has its well outlined indications and limitations, is justified and preferable to gastrostomy and mechanical dilatation, provided the patient's general condition is still good enough to support the procedure and provided no metastatic foci can be demonstrated. It is, however, equally obvious that this procedure has produced what can be called permanent cures in such exceptionally rare instances that we should consider these accomplishments as curiosities rather than as promising future progress with this technic. How careful we must be with the interpretation even of apparently cured patients is shown by Baum's case. His patient, treated with 15,000 r (200 kv.) through three portals, was reported radiologically symptom-free for six years in 1936. In a recent personal communication, Doctor Baum informed us that this patient remained free of clinical and radiological evidence of disease for nine years but during the tenth year had a local recurrence and subsequently died of pulmonary and liver metastases. In the light of this experience, it seems futile to put too much emphasis on a number of cases reported in the literature as cured for two to five years. Some of the late results, furthermore, are those encountered in the upper third of the esophagus, which is outside this discussion (Pohle, Nielsen, Zuppinger).

Nielsen attempted to discover the reasons for the different results in tumors located in the cervical and those located in the intrathoracic portion of the esophagus. He found the efficient tumor dose to be about 4,000 to 4,500 r given in a period of from six to seven weeks. He gave to his cervical tumors between 6,000 and 12,000 r, the tumor dose varying between 3,000 and 6,000 r. For the tumors of the intrathoracic portion this problem cannot be solved with 200-kv. radiation. It is necessary to use five or six fields. A daily dose of more than 350 r is usually not tolerated; a daily dose below 300 is usually not efficient. It is difficult to apply more than 12,000 r without severe complications if the fields are reasonably large. Strandqvist comes to about the same conclusion with regard to the dose applied to the tumor. In those patients who remained well for two years, the tumor dose was 4,350 to 5,000 r given over a period of thirty-five to forty days. He believes that, were it possible to apply a total tumor dose of 5,000 to 6,000 r in thirty to forty days, the results would improve.

These experiences with 200-kv. x-ray therapy show conclusively that the tumors are essentially responsive to radiation therapy and that the obstacle to complete sterilization may well be found in the inadequate tumor dose. The degree of radiosensitivity of these neoplasms, as evidenced by their response to 200 kv. radiation, is in agreement with the pathological type of tumor—gross and microscopic—found in the esophagus. The detailed histological classification of 139 cancers of the esophagus by Zuppinger shows the following distribution: 85 cases, or 61 per cent, squamous-cell carcinoma; 22 cases, or 16 per cent, carcinoma simplex solidum; 22 cases, or 16 per cent, semi-epidermoid carcinoma; 7 cases, or 3.6 per cent, adenocarcinoma. Of 52 squamous-cell carcinomas, of which the slides were still available at the time of his review, Zuppinger found 41 of the mucous membrane type and 11 of the skin type of differentiation. This indicates that the undifferentiated cancers, or those of a low degree of differentiation, represent at least 30 per cent of the epidermoid carcinomas of the esophagus. From a biological point of view then, these tumors are similar to those of the mucous membrane of the oral

cavity and of the cervix uteri. They do not represent very highly radiosensitive tumors, but they are of a degree of radiosensitivity compatible with their curability by radiation without intolerable damage to the surrounding structures.

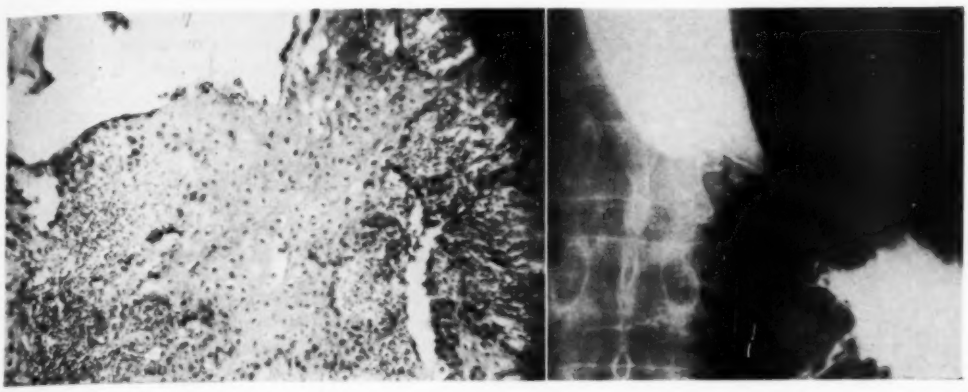
From the gross pathologic appearance, it is possible to differentiate exophytic or polypoid tumors from the more infiltrating types. In Zuppinger's series 50 per cent were exophytic carcinomas, 44 per cent infiltrating, and 5 per cent he could not classify. In most cases it is possible to come to some conclusion as to the gross type of tumor from the radiologic appearance and clinical symptoms. Esophagoscopy will add assurance to the clinical classification. As one would expect, Zuppinger found that the polypoid tumors responded to radiation therapy to a greater extent than the infiltrating forms and, since they also metastasize later, they should represent those most amenable to roentgen therapy.

On the basis of clinical as well as general pathologic considerations, it seems logical to assume that a high percentage of carcinomas of the thoracic esophagus are essentially amenable to external radiation therapy and that an improvement in technical details may insure curability of a certain number, as in the case of other epidermoid carcinomas located in a physically more favorable position. Logically the increase in penetration should constitute a definite step forward toward this goal.

It was therefore with great eagerness that in 1939 we accepted the opportunity to treat carcinomas of the esophagus with 800-kv. apparatus. We have, however, in the ensuing four and one-half years seen only 10 carcinomas of the esophagus, although elsewhere we had had 2 or 3 cases under treatment at any given time. It seems that the number of carcinomas of the esophagus in this part of the country is actually small, for thoracic surgeons, as well as some of the more active x-ray diagnosticians, inform us that they rarely see a case. It may be, also, that the condition is generally considered so hopeless that any form of treatment seems futile and the patient is not referred to a thoracic surgeon or x-ray diagnostician—to say nothing of a radiotherapist. As a matter of fact, even some radiologists consider gastrostomy as the palliative procedure of choice, probably because the dose of radiation usually applied has been too low to produce any result. Case 2, recorded below, is an instructive example of this attitude. We have seen cases treated with 140-kv. radiation, a procedure which will quite naturally discourage the sending of such patients for radiation therapy. This type of treatment will discredit the whole field of radiation therapy in esophageal cancer in the eyes of patients, practitioners, and surgeons alike.

Naturally radiotherapy should be considered only if the patient's general condition is fair, if the weight loss is not too great, and if there is no demonstrable evidence of spread of the disease beyond the esophagus. A report by Watson and Urban seems to substantiate this conclusion. In a group of 21 patients with intrathoracic carcinomas of the esophagus treated with million-volt roentgen rays, 17 (81 per cent!) showed an extreme loss of weight, 4 had enlarged lymph nodes, 5 had liver nodularities, and 12 required a preliminary gastrostomy. We would feel that the majority of these cases were unsuitable for irradiation. It is not surprising, therefore, that at the time of the report only 1 out of this group of 21 patients had remained without sign of recurrence for thirty months after treatment.

Of our 10 patients, 4 were refused treatment because they had either demonstrable metastases or the general condition was not sufficiently good to support so formidable a procedure. In 1 case treatment was discontinued after only a small amount of radiation had been given, because of rapid deterioration. We have therefore treated only 5 patients with doses considered adequate. One of these is without radiological evidence of local recurrence after three and a half years (Case



Figs. 1 and 2. Case 1: Biopsy specimen showing squamous-cell carcinoma, grade 2, and initial roentgenogram (April 27, 1940).

1). One shows a recurrent stenosis, probably with liver metastasis, after two years (Case 2). One patient, who showed radiologically a penetrating ulcer in an infiltrating stenosing carcinoma at the beginning of treatment, had a temporary improvement of the stenosis for about four months and then died after eleven months with local recurrence and liver metastases (Case 3). One patient died after three months, apparently of perforation with lung abscess. One patient, with an extensive anaplastic polypoid carcinoma, died after four months with extensive liver metastases. It should go without saying that the number of cases is much too small and the time too short to permit definite conclusions. The only excuse for this premature report is the hope that we might have a chance to discuss these problems openly in order to improve the technical approach and stimulate reports by others who have a larger material available. We feel that, in a field in which final conclusions cannot be reached until at least five to ten years of observation have elapsed, we are justified in pausing at times to evaluate our observations to date in order to recognize what a new procedure has or has not accomplished, and to consider where improvements are possible on the basis of our existing knowledge. Such a discussion is warranted in order to give patients the benefit of past experience, no matter how meager. The following case reports are presented only with these reservations.

Treatment was administered with 800 kv., 100 cm. T.S.D., and an essential filtration of 4.5 mm. lead, giving an exposure rate of approximately 25 r per minute for the fields used. All doses were measured on the skin.

CASE 1: B. B., 47-year-old male, was admitted April 15, 1940. In September 1939 he had what he thought was a chest cold, which persisted for about one month and was associated with hiccough following meals. He was examined radiologically but nothing was found. About two weeks following the radiologic examination, he was re-examined and at that time an irregularity was discovered in the esophagus. Esophagoscopy was then done and a biopsy specimen was reported as not malignant.

In the early part of January 1940, because of persistent pain after eating and loss of weight, the patient went to the Mayo Clinic, where a diagnosis of cancer of the esophagus was made. The report describes a lesion involving the distal portion of the esophagus and the lesser curvature of the stomach at the cardia (Dr. H. H. Schmidt). Esophagoscopy showed an ulcerated bleeding lesion at the cardia. A biopsy specimen was taken through the esophagoscope and a squamous-cell epithelioma, grade 2, was found (Fig. 1). Dilatation (up to 45 French) was done and the patient was advised against further therapy.

Fluoroscopic examination by Dr. T. W. Blake, following admission to the Swedish Hospital (April 1940), showed a carcinoma, apparently involving 2 inches of the esophagus above its entrance into the stomach. There was also involvement of approximately 2 inches of the upper part of the stomach, especially on the lesser curvature side (Fig. 2).

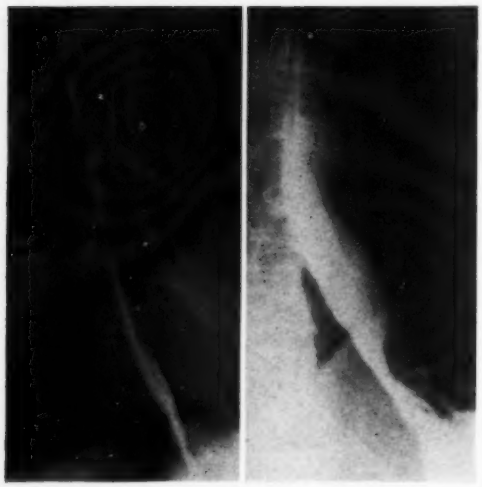


Fig. 3. Case 1: Roentgenograms made Oct. 13, 1941.

While the patient had declined in weight from 175 pounds prior to the onset of symptoms to 126 pounds at the beginning of irradiation, he had reached 137 pounds at the end of treatment. Swallowing improved after about 2,300 r and throughout the treatment he ate well, usually six meals a day, without regurgitation or discomfort. He steadily regained strength while under treatment. At the completion of therapy there was a moist radio-epidermitis over both anterior and posterior fields, which healed within three or four days. Fluoroscopic examination on May 11, 1940, after 6,000 r were delivered, showed the passage completely open for liquids and without stenosis. There was still a filling defect in the lower esophagus surrounded by an apple-sized shadow apparently representing the tumor.

On July 8, 1940, the patient informed us by letter that his weight was 145 pounds and that he was eating everything. He was re-examined on Oct. 13, 1941, one and a half years after treatment. His general condition was excellent, his weight 160 pounds. He stated that he ate everything without difficulty and had no pain or cough. He had been working full time during the past year. Fluoroscopic examination showed some, but not marked, residual narrowing of the distal two inches of the esophagus and some indication of rigidity of the medial wall of the stomach for a distance of approximately one inch adjacent to the site of insertion of the esophagus into the stomach (Fig. 3).

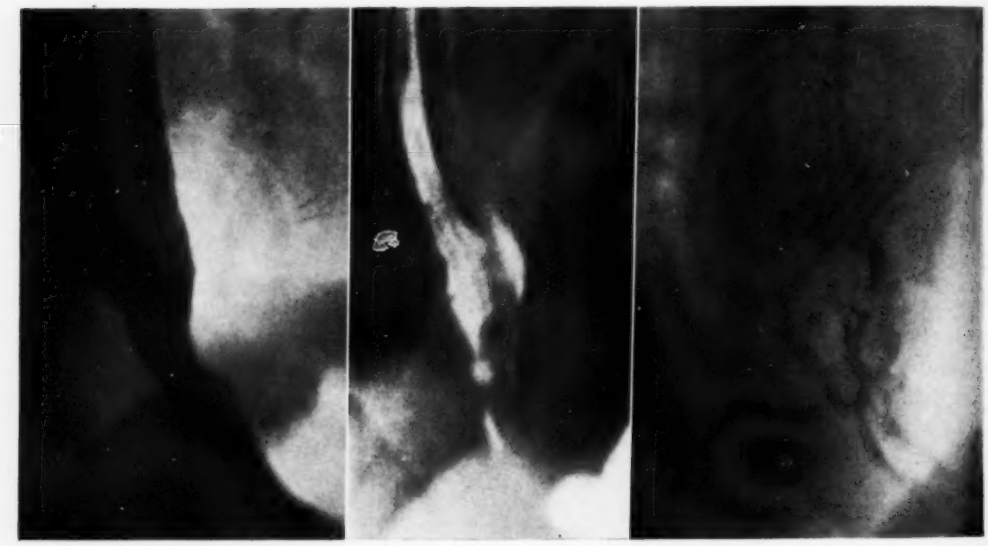


Fig. 4. Case 1: Roentgenograms made Nov. 24, 1942 (Courtesy of Dr. F. Templeton).

The patient received x-ray therapy between April 15 and May 30, 1940, as follows: anterior epigastric field, 3,500 r; posterior epigastric field, 4,450 r; second anterior epigastric field, 1,900 r. Total 9,850 r in 46 days.

There was a partial overlapping of the two anterior fields. The first field included the stenotic area of the esophagus only, while the second field attempted to include the cardiac extension of the lesion. Field sizes varied between 10 × 14 and 9 × 10 cm., being mainly 10 × 10 cm.

On Nov. 24, 1942, the patient was examined by Dr. F. Templeton of the University of Chicago (Fig. 4). His report follows: "The esophagus, stomach and duodenum are normal except for some distor-

tion of form in the lower end of the esophagus. Peristaltic waves passed through the esophagus to the stomach. There was not the slightest suggestion of neoplasm. Peristaltic waves began high on the stomach, then progressed through the antrum. The duodenal bulb was normal. The fundus of the stomach filled out well.

"Serials 1 to 4 inclusive, multiple views of the lower end of the esophagus and stomach. First view, serial 4, made during the passage of first swallow of barium into the stomach. This view and the third view of serial 4 show the lower end of the esophagus well filled. The distortion of the mucosa suggestive of radiating folds about 2 cm. above the level of the diaphragm is shown on first view, serial 3, third view, serial 2.

"*Impression:* Except for some scarring in the lower 2 or 3 cm. of the esophagus, I see no evidence of lesion. Patient is in excellent general condition, is keeping his weight around 160 pounds, and is working full time without any subjective complaints."

CASE 2: J. R., 62-year-old male, was admitted July 30, 1941. For two and a half years he had complained of indigestion and lack of appetite, and for the past year he had had difficulty in swallowing. Since September 1940, he had been able to swallow only liquids. *At that time he was examined by a radiologist, who recommended gastrostomy only.* Since then the esophagus had been *regularly dilated.* At the examination in September, a stenosis of the middle third of the esophagus with prestenotic dilatation was found. The patient's weight at that time was 163 pounds. On admission he weighed 122 pounds. Only a small amount of liquid could be passed. When he was admitted, he had received roentgen therapy elsewhere, between June 25 and July 9, 1941, *a total of 1,260 r with 0.25 mm. copper (?),* voltage not stated.

X-ray examination by Dr. T. W. Blake, on July 30, 1941, showed a carcinoma at the level of the 7th dorsal vertebra, with some obstruction (Fig. 5).

Esophagoscopy by Dr. James Blackman, on Aug. 12, showed the mucosa greatly thickened and rough in appearance at the junction of the upper and middle thirds of the esophagus. The lumen was reduced to approximately 0.5 cm. in diameter by a polypoid tumor. A specimen taken from this mass showed squamous-cell carcinoma.

Between Aug. 13 and Sept. 23, 1941, the patient received the following roentgen therapy with 800 kv.: anterior mediastinum 5,150 r; posterior mediastinum 4,950 r (Fig. 10). Total 10,100 r in 41 days. Field sizes 8 × 10 to 10 × 10 cm.

After fifteen treatment days, or about 3,000 r, the patient experienced more difficulty in swallowing and excessive salivation, indicating an increase of the obstruction. The dose was then somewhat reduced and after about 4,000 r, on the 20th treatment day, there was an improvement in swallowing and general condition. Beginning Sept. 18, 1941, there was again a deterioration, and the patient was unable to swallow. Treatment was therefore discontinued until the obstruction had improved and feeding once more became possible on Sept. 29.

Fig. 5. Case 2: Roentgenogram made July 30, 1941, showing carcinoma at the level of the 7th dorsal vertebra.

Fluoroscopic examination on Oct. 6, 1941, showed no obstruction and an almost normal esophagus. There was a small area of narrowing at the site of the former obstruction, which could be demonstrated only with paste-like barium. There was no prestenotic dilatation.

On the 33d treatment day there was a beginning moist reaction over the anterior field, which healed in ten days. There was a severe erythema over the posterior field only.

Following the improvement as evidenced by clinical observation and x-ray examination on Oct. 6, 1941, *additional roentgen therapy* was given to one anterior oblique (60 degree) field of 10 × 12 cm., 4,750 r being delivered to this field in 17 days.

On Oct. 13, 1941, on the 63d treatment day, after 12,350 r had been given, the patient complained for the first time of pain over the treated area on swallowing, probably indicating a reaction of the esophageal mucosa. During the following days there were occasional acute and apparently spastic occlusions of the esophagus, lasting only a few minutes each time, probably due to the irritability of the esophageal mucosa during the radiation reaction.

On Oct. 27, 1941, a second esophagoscopy was done by Dr. James Blackman. Stenosis was again encountered at the junction of the superior and middle thirds of the esophagus. A small tag of tissue

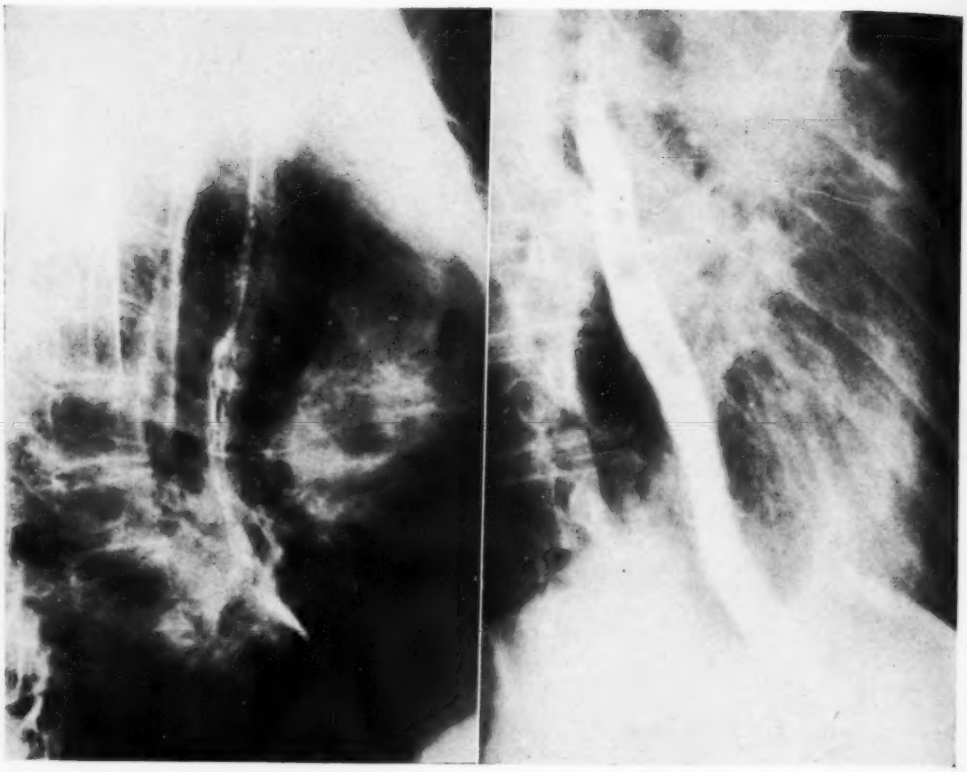
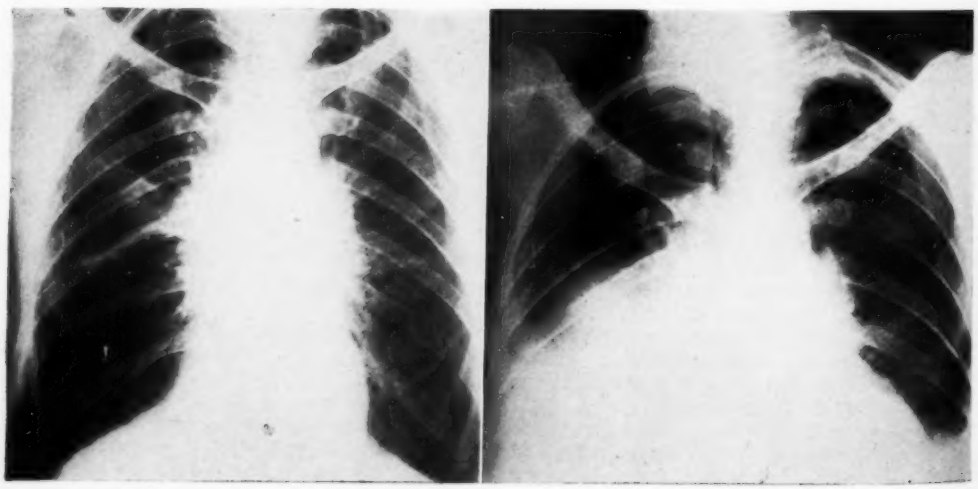


Fig. 6. Case 2: Roentgenograms made Feb. 17, 1942.



Figs. 7 and 8. Case 2: Chest roentgenograms showing (left) radiation fibrosis (Feb. 17, 1942) and (right) mediastinitis (Sept. 20, 1943).

protruding into the lumen at about the 7 o'clock position was found. This tag was smooth and covered with apparently normal mucosa. The instrument could be passed approximately 1 cm. beyond the first abnormality and the lumen was then found reduced to approximately 1 cm. in diameter. This reduction was caused by a rather large polypoid growth in the left lateral wall. The esophageal lumen was at least twice the size it was at the first esophagoscopic examination and the tumor was now smooth in outline and apparently covered by normal esophageal mucosa.

Between Oct. 28 and Oct. 31, 1941, additional roentgen therapy, 1,350 r through one left posterior oblique field of 10 × 10 cm., was given. This brought the *total amount of radiation to 16,200 r in 81 days.* There was an 8-pound gain in weight during the treatment period.

Re-examination on Dec. 12, 1941, showed the patient to be in good condition, with the same weight as on discharge. He could swallow all liquids without difficulty but stated there was some delay in the mid-thoracic region on swallowing of solids. X-ray examination at this time showed a diminution in the amount of obstruction. There was still a slight narrowing of the esophagus at the level of the 7th dorsal vertebra, but this was apparently associated with spasm, since there was considerable distensibility of the esophagus at the site of the previous lesion.

The patient was re-examined on Feb. 17, 1942, three and a half months after completion of roentgen therapy. At this time he could swallow everything. Only occasionally, very solid food produced a sensation of retardation for a short while before it passed on. On fluoroscopy the esophageal passage was completely free for fairly thick barium and there was normal expansion in the region of previous stenosis. There remained a slight irregularity in this area toward which the mucosal folds converged (Fig. 6). The x-ray examination of the chest showed a diffuse opacity in the hilar region, extending symmetrically as smooth bands to the left and to the right (Fig. 7). From this examination it was impossible to determine whether this was a beginning mediastinal and pulmonary fibrosis or an extension of the disease from mediastinal metastatic foci. The symmetrical character of this lesion was interpreted as in favor of fibrosis.

The patient was last seen on Sept. 20, 1943, when he stated that he was swallowing well until November 1942. Since that time he had again experienced difficulty with solid foods and could swallow only semisolids and, during the last two months, only liquids. He was in a very reduced general condition. Fluoroscopically a stenosis at the level of the 7th dorsal vertebra was again demonstrable (Fig. 9). Only very thin barium passed at this level. X-ray study of the chest showed a massive extension into the right lung with partial atelectasis, indicative, in all likelihood, of progression of mediastinal metastases into the right lung. There was a moderate amount of fluid in both pleural cavities. However, the possibility of a severe radiation fibrosis and mediastinitis must be considered, if one compares the chest findings on Figures 7 and 8. The liver was greatly enlarged and nodularities were palpable on the anterior surface. There was an edema of both legs. The main complaint was dyspnea.

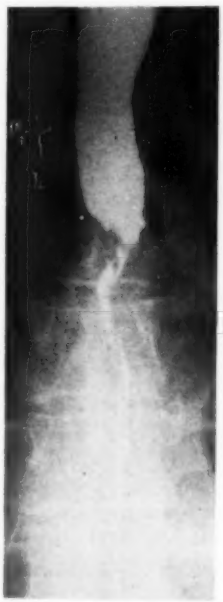


Fig. 9. Case 2: Sept. 20, 1943.

This case is considered a failure, although from our findings it is not possible to determine whether the patient's condition is due to recurrent disease or to a severe mediastinal fibrosis with mediastinitis. The comparison of the films of Feb. 17, 1942, and Sept. 20, 1943, suggest this possibility to us in view of the excessive amount of radiation received. We believe that the patient was overtreated, and so excessive a dose will be avoided in the future, since we know from experience with other cancers that a cure cannot be forced by an increase in the dose only.

CASE 3: A. R., 65-year-old white male, was admitted Jan. 16, 1940. In November 1939, he first noticed a stoppage when he ate solid food. For one month he could take only liquids. There was occasionally a regurgitation of whitish material, but no bleeding or pain. Later there had been some cough. Apparently there was no considerable loss of weight. The average weight was 178 pounds; weight on admission 155 pounds.

On examination the patient was found in good general condition. Clinically nothing abnormal was found with the exception of an enlarged liver, palpable about 4 cm. below the costal arch in the mid-

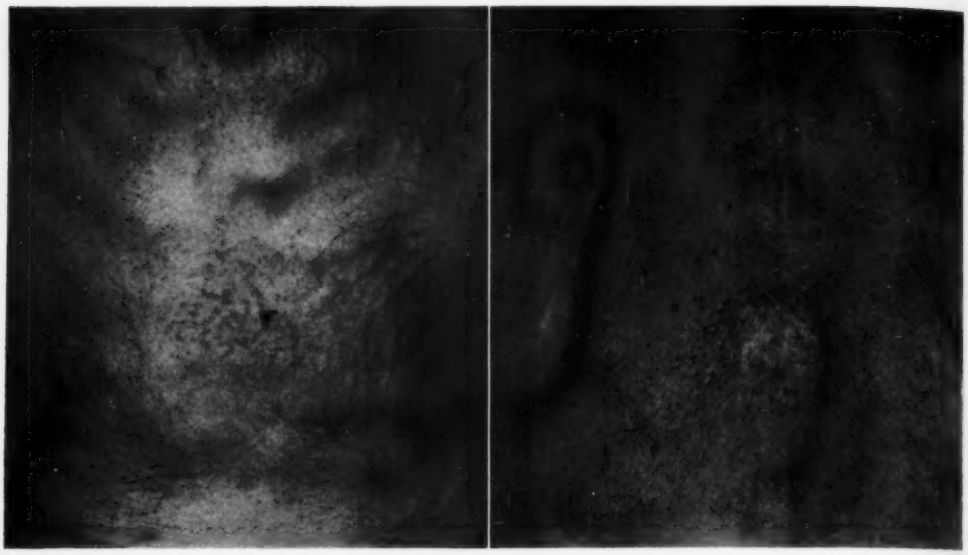


Fig. 10. Case 2: Skin reaction after 5,150 r in 41 days to anterior field (left) and 4,950 r in 41 days to posterior field (right).

line. There was an ill-defined lump palpable under the right rectus muscle in the region of the liver, apparently moving with the liver on inspiration. The pulse was 120, with an irregularity which clinically gave the impression of a fibrillation. On electrocardiographic examination, this was diagnosed as an auricular flutter 3 to 1, ventricular extrasystoles.

Fluoroscopic examination by Dr. T. W. Blake showed a carcinoma at the junction of the lower and middle third of the esophagus at the level extending from the upper circumference to the lower circumference of the 10th dorsal vertebra. The length of the lesion was 2.5 cm. There was a small ulceration demonstrable in the lateral circumference to the right of the stenotic canal, indicative probably of imminent perforation (Fig. 11A).

The patient received roentgen therapy, between Jan. 18 and March 15, 1940, with 800 kv., as follows: anterior field, 4,578 r; posterior field 4,150 r; right anterior oblique 3,000 r; left posterior oblique 1,000 r. Total, 12,728 r in 53 days.

While during the first two and a half treatment weeks the patient was swallowing liquids well, there was increased regurgitation of fluids beginning on the 19th day with increasing difficulty in swallowing and some subjective complaint of associated soreness. This was interpreted as due to an edema around the lesion, since the dose at that time was only around 3,000 r. This difficulty cleared up rapidly, and after 6,000 r were delivered the patient could, beginning on the 36th day, swallow semisolid foods easily. From then on there was a steady improvement of the clinical symptoms of stenosis. At the end of treatment there was a moist epidermitis over the anterior field, with a deep erythema and scaling over the posterior fields. This healed rapidly.

Fluoroscopy on the 40th treatment day showed the barium passing freely and no stenosis (Fig. 11B). X-ray examination on March 25, 1940, showed the barium passing easily throughout the esophagus. There was still an irregularity in the anterior and posterior circumference extending for 3.5 cm. Altogether, the comparison of this examination with the examination prior to treatment showed a marked improvement.

On May 11, 1940, the patient was in excellent condition, eating everything without difficulty. There was no trace of radiation reaction over the anterior field at this time. There was some residual desquamation with bronzing over the posterior field. The weight was 170 pounds, a gain of 15 pounds.

In June 1940, the patient again noticed difficulty in swallowing and when he returned on July 1, 1940, for re-examination, he was unable to take solid foods. There was no pain in the chest nor cough. Fluoroscopy showed a stenosis at the site of the former lesion. There was practically the same amount of obstruction as was seen at the time of examination on Jan. 16, 1940.

On Dec. 4, 1940, the patient reported by letter that he could still swallow liquids and semiliquids but that he had again lost weight and weighed only 128 pounds.

Death occurred on Feb. 5, 1941. The postmortem examination, by Dr. Straumfjord in Astoria, showed a carcinoma of the esophagus measuring 5.5 cm. in

length. There was a lymph node measuring 2 cm. in diameter behind the esophagus at its cardiac end. Metastases were found in the liver. Sections from liver and esophagus showed carcinoma.

DISCUSSION AND CONCLUSIONS

The cases recorded above are obviously meaningless from the point of view of proving or disproving the possibility of cure of esophageal carcinoma by supervoltage roentgen therapy. The fact that one patient was clinically and radiologically well for three and a half years does not demonstrate the superiority of 800-kv. over 200-kv. radiation, since occasional instances of

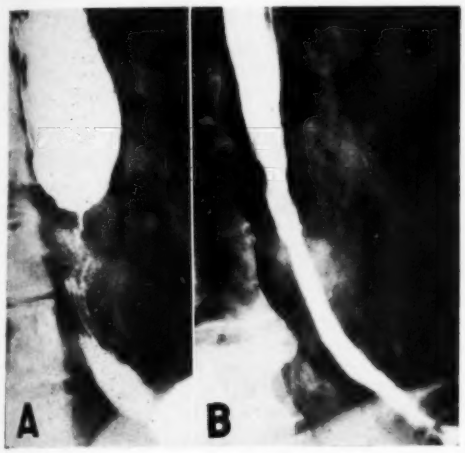


Fig. 11. Case 3.

freedom from symptoms for even longer periods following irradiation at 200-kv. have been reported as therapeutic curiosities. However, careful clinical observations and their evaluation in comparison with the more extensive experience with 200-kv. radiation, as well as theoretical considerations, have convinced us that it is worth while to continue work in this direction, and we believe that this procedure may enable us in the future to cure a certain number of carcinomas of the thoracic esophagus with more regularity.

The response of esophageal carcinomas to 200-kv. radiation has shown conclusively that they are essentially amenable to radiation therapy, since they exhibit a uniform and predictable response, indi-

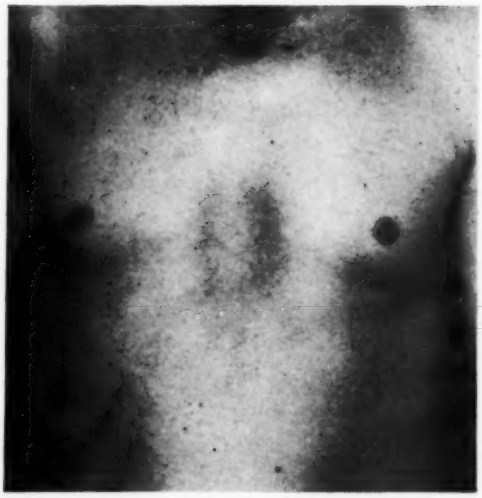


Fig. 12. Case 3: Anterior field after 4,580 r in 43 days (July 1, 1940).

cating a degree of radiosensitivity which is to be anticipated from their microscopic structure. That cures are only rarely accomplished, and results are merely palliative, is due to well understood physical as well as clinical considerations.

An approximate physical calculation and measurements demonstrate that it is physically impossible to introduce adequate cancer-sterilizing doses into tumors at this location with 200-kv. radiation. From experience with tumors of similar histology in other locations, we may assume that approximately 5,000 r, delivered to the tumor within four to five weeks, may be an average sterilizing dose. The distance of a carcinoma of the esophagus, at the level of the hilus, in a patient of average build, is approximately 11.5 cm. from the anterior and 10.5 cm. from the posterior chest wall (Zuppinger). As can be seen from Table I, which records measurements in a presdwood phantom at these levels, the depth dose with 200 kv. is approximately 35.2 and 38.8 per cent of the skin dose, respectively, with a field 10 × 14 cm. With decreasing field size the conditions become even less favorable at this voltage. The skin will not well tolerate more than 4,000 r as a maximum with adequate fields and 200 kv. With this skin

TABLE I: TUMOR DOSE AT 10.5 CM. AND 11.5 CM. DEPTH, MEASURED IN PRESDWOOD PHANTOM (Field Size, 10 × 14 cm.)

	200 Kv. 2 mm. Cu, 70 cm. T.S.D.	800 Kv. 4.5 mm. Pb, 100 cm. T.S.D.
Skin dose	100	100
Depth dose 10.5 cm.	38.8%	50.8%
Depth dose 11.5 cm.	35.2%	44%

exposure the dose delivered to the tumor through the anterior portal is about 1,408 r; through the posterior portal, 1,552 r. Thus a total of 2,960 r will be delivered into the tumor through the anterior and posterior fields combined. Actually, it will usually not be possible to give more than 3,500 r over one skin field, which further reduces the tumor dose. In view of these facts, treatment with 200-kv. radiation is always given through more than two portals, and in very careful calculations Zuppinger has demonstrated that, at each level of the esophagus, a different selection of fields would improve the tumor dose. His calculations have taken into account that for some oblique and lateral fields the air-containing tissues are mainly traversed and that the difference in distance is thus partly balanced. As we shall see presently, however, the use of large fields has the disadvantage of a very considerable volume dose and the additional difficulty of inaccurate aiming for the oblique portal, with the consequent necessity of increasing the field size in order to be certain that the tumor is included.

Measurements with 800-kv. radiation of the type we have used have shown that the depth dose at 10.5 cm. is 50.8 per cent and at 11.5 cm. 44 per cent. With this type of radiation the skin can easily tolerate 5,000 r in a period of four to five weeks, with only a mild moist reaction which heals within a few days. Consequently, it is possible to introduce into the tumor through the anterior field an approximate tumor dose of 2,200 r and through the posterior field 2,540 r, or a total of 4,740 r, utilizing only one anterior and one posterior field. This means that with supervoltage it may be possible to apply an adequate tumor dose by using anterior and posterior fields only. Oblique fields may be added to increase the tumor dose when this is required, but it may not be necessary to add as much through these portals as is done with 200-kv. radiation in order to obtain equal distribution over four or six fields.

The clinical observation of our patients under treatment has shown that supervoltage radiation is tolerated much better than 200-kv. radiation for this type of lesion. This is due in part to the quality of the radiation itself; partly, however, to the possibility of reducing the field sizes, since we can apply the greater portion of the treatment through one anterior and one posterior field. For these the aiming is considerably more accurate than for the oblique fields, which must therefore be larger. It must also be considered that the skin reaction over as large an area as is covered by four or six chest fields has in itself a considerable influence on the patient's general condition.

In order to improve the accuracy of positioning for the oblique fields, a wooden arch, which we have constructed, is placed over the patient's chest during fluoroscopy and the angulation of the body in relation to the table is outlined on the skin (Fig. 13). It is thus possible, by comparing the skin marks with the position of the wooden arch, to reproduce exactly the same position every day.

In respect to the indications for roentgen therapy in carcinoma of the esophagus and the question of a preliminary gastrostomy, we feel that these have now changed. We believe that with 200-kv. radiation no cures can be accomplished; that all we can attempt is improvement of the obstruction in order to avoid gastrostomy. We therefore feel quite strongly that, so far as 200-kv. radiation is concerned, a preliminary gastrostomy defeats the purpose of the procedure and we accordingly refuse patients with gastrostomy for palliative treatment only.

For 800-kv. radiation the situation is otherwise. Here we still hope to attain a

cure but we realize that the procedure is of such a magnitude that only a patient in good general condition can support it. It is evident that the patient should be treated as thoroughly as possible, and this means that fluids at least should be able to pass freely in order that he may obtain adequate nourishment during therapy. Patients who have lost too much weight are not in a condition to support this treatment. If there is some hope of cure and we believe that the poor general condition is due to starvation rather than to cachexia from tumor, we feel that a preliminary gastrostomy is indicated in order to make it possible for the patient to support the treatment. It should be kept in mind, however, that gastrostomy is not as harmless a procedure as it is usually considered. We therefore feel that it should be avoided whenever possible, not only because of the primary risk of the operation itself, but also because of its psychological effect. The gastrostomy and accompanying skin irritation also limit the skin tolerance in the anterior field. It is sometimes possible in border-line cases to proceed with small doses of radiation in order to avoid a complete obstruction by the accompanying edema and thus reduce the stenosis and improve the general condition while treatment is progressing. The dose is later increased according to the tolerance of the patient. It goes without saying that these patients must be hospitalized if the treatment is to be conducted with the least risk. Only then is it possible to save all their strength for the treatment, to insure a high-caloric diet, and to administer sufficient fluids for the improvement of their general condition. If the treatment is conducted successfully, the patient's weight will increase and his strength will improve while he is under treatment. That much we have learned by the few cases we were able to treat.

On the basis of this very limited experience, together with our previous experience with 200-kv. radiation, we feel confident that an improvement of technic will, in all likelihood, enhance the curability of

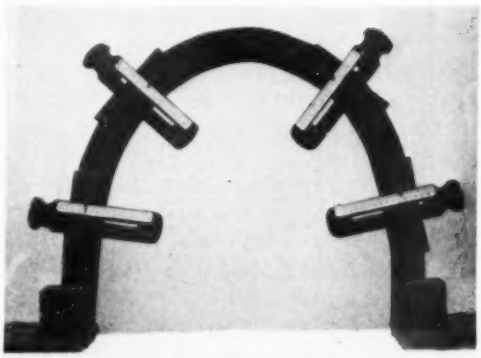


Fig. 13. Localizer for oblique fields.

carcinomas of the esophagus in its intrathoracic portion. We believe that this should be one of the main fields in which supervoltage therapy will have definite advantages over medium voltage both for theoretical reasons and because of the results and limitations of 200-kv. radiation therapy observed in our practical experience. It seems to us that the outlook for carcinoma of the esophagus is more favorable than for carcinoma of the bronchus, since an esophageal cancer usually produces symptoms in a fairly early stage, while patients with bronchiogenic carcinoma almost always have regional lymphatic metastases by the time the primary lesion can be clinically recognized.

It will probably be possible by improved technic and increasing experience to cure a certain number of those intrathoracic esophageal carcinomas which are not yet accompanied by lymph node metastases. Whether we will ever be able to cure carcinomas with lymph node metastases in the mediastinum seems extremely doubtful. Even for palliative purposes, as for temporary improvement of a stenosis in order to avoid gastrostomy, we feel, on the basis of our limited experience, that supervoltage treatment is superior to treatment at 200 kv. It is better tolerated and has considerably less influence on the patient's general condition than treatment at lower voltages.

In concluding, we wish again to emphasize that radiation therapy of carcinoma of

the esophagus should be attempted only if there is reasonable hope for either satisfactory palliation or permanent cure, only in those patients whose general condition is good enough to support a procedure of this magnitude, and only when the external circumstances are sufficiently favorable for adequate clinical supervision. Radiation therapy of carcinoma of the esophagus requires a skillful clinical evaluation of all possibilities, including a careful appraisal of the patient's general condition and the condition of his circulatory organs. In other words, it is a clinical as well as a technical procedure.

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The Place of the National Cancer Institute in the Cancer Program[1]

R. R. SPENCER, M.D.[2]

Medical Director, United States Public Health Service

GENESIS

THIRTY years ago professional and lay groups in the United States joined hands to launch the American Society for the Control of Cancer, a movement which had as its objective the education of physicians and the public to an effective understanding of the primary importance of early diagnosis and prompt, expert treatment of cancer. Supported by the American Medical Association and the American College of Surgeons, this movement has succeeded beyond all expectations. It was climaxed, we believe, in the passage of the National Cancer Institute Act of August 5, 1937. The Women's Field Army of the American Society has grown until there are now well organized units with commanders and subordinate personnel in 46 of the 48 states.

Twenty-three thousand voluntary workers have distributed more than four million pieces of literature giving information about cancer. An enlightened public has been made cancer-conscious and has now sensed that the fight against cancer, like that against mental disease, tuberculosis, and syphilis, requires something more than the medical care administered to the private patient by the private physician under a strictly confidential relationship. It has realized that education alone is not enough. If our incomplete knowledge of the cause, diagnosis, and treatment of cancer is to be increased, painstaking and carefully planned research must be continued and expanded. Furthermore, if the immediate cancer victim is to receive adequate modern treatment, expensive tools, special equipment, organized cancer services, and physicians highly trained in tumor surgery, tumor pathology, and in radiology are essential. This is the background of activities which cleared the way for the passage of Federal legislation. It was therefore not surprising that the National Cancer Institute Act received almost universal social approval. This was attested by the fact that 96 members of the United States Senate attached their names to the bill creating the National Cancer Institute as a division of the United States Public Health Service. Never in the history of the republic had the entire membership of either body of Congress sponsored a piece of legislation! Thus cancer was recognized as a national medico-socio-economic health problem.

THE NATIONAL ADVISORY CANCER COUNCIL

Under the provisions of the National Cancer Institute Act, a National Advisory Cancer Council was created, consisting of six members selected from the ranks of medical and scientific authorities who are outstanding in the study, diagnosis, or treatment of cancer, or in related fields, in the United States. The Surgeon General of the United States Public Health Service acts as chairman of the Council, *ex officio*.

The Council is authorized by the act:

(*a*) To review research projects or programs submitted to or initiated by it relating to the study of the cause, prevention, or methods of diagnosis and treatment of cancer. . . .

(*b*) To collect information as to studies which are being carried on in the United States or any other country as to the cause, prevention, and methods of diagnosis and treatment of cancer . . . and . . . make available such information through the appropriate publications for the benefit of health agencies and organizations (public or private), physicians, or any other scientists, and for the information of the general public.

[1] Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1–2, 1943.

[2] Chief, National Cancer Institute, National Institute of Health.

(*c*) To review applications from any university, hospital, laboratory, or other institution, whether public or private, or from individuals, for grants-in-aid in the case of such projects which show promise. . . .

(*d*) To recommend to the Secretary of the Treasury for acceptance conditional gifts pursuant to section 6. . . .

TRAINING IN DIAGNOSIS AND TREATMENT

Section 5 (*b*) of the National Cancer Institute Act authorizes the Surgeon General:

> To provide the necessary facilities where training and instruction may be given in all technical matters relating to diagnosis and treatment of cancer to such persons as in the opinion of the Surgeon General have proper technical training and shall be designated by him for such training. . . .

Fifty-six young physicians who expressed a special interest in cancer therapy, and who were carefully selected from a large number of applicants, have been given postgraduate training in tumor diagnosis and treatment under the provisions of this section of the act. The men receive one, two, or three years' training, according to their individual needs. Not all institutions are equipped and staffed or have access to sufficient clinical material to give the very highest type of training desired, but there are some, such as Memorial Hospital in New York City, where the training is well organized and where each trainee functions as a junior member of the staff and devotes one year each to tumor surgery, tumor pathology, and radiation therapy. Practically all these men take the training course with the view of subsequently becoming diplomates of the American Board of Surgery, or Pathology, or Radiology. Upon the completion of training, they are capable of setting up and directing tumor clinics to conform to the standards of the American College of Surgeons. It is becoming more and more evident that modern and adequate cancer therapy can be provided only by the co-ordinated and intelligently guided efforts of highly trained experts in surgery, pathology, and radiology. Even if these cancer trainees go into private practice after completing the course, they are certainly more valuable as practitioners because of their training than they would have been without it. This is particularly true in small communities where there are no tumor clinics. We believe that this selection and postgraduate training of young physicians who have displayed a special interest in cancer therapy is one of the most effective means of rendering assistance to the immediate cancer victim.

LOAN OF RADIUM

The National Cancer Institute has purchased 9.3 gm. of radium. Approximately 8.0 gm. has been loaned to various hospitals throughout the country for the treatment of patients. The loan regulations require that this radium be used for treatment purposes only by persons whose qualifications are the equivalent of the standards established by the American Board of Radiology. No charge is made for the use of this radium, and preference must be given to indigent patients. At present 47 hospitals are enjoying the advantages of the Government-owned radium.

STATES RELATIONS

The Cancer Institute Act authorizes and directs co-operation with state health agencies in the prevention, control, and eradication of cancer. Accordingly, there was established an office in the National Cancer Institute which studies state cancer-control legislation and activities and provides consultation service to health agencies requesting such aid.

The programs of the various states vary in scope. In general state activities may be classified under the following broad headings: (1) provision of free or part-pay state aid for diagnosis and treatment of cancer patients; (2) free tissue diagnosis; (3) lay and professional education; (4) statistical and epidemiologic research, including a system of follow-up of cancer cases.

At least two states (New York and Massachusetts) participate in all of these

activities, while others carry on only one or two of them. Twelve states have a division of cancer control and a full or part-time director within the state health department. Three states (Missouri, New Hampshire, and Vermont) have state cancer commissions independent of the respective state boards of health. We do not think it wise, as a rule, to separate state health activities and would not recommend independent divisions to states contemplating cancer-control legislation. The problem is, of course, not the same in sparsely populated rural states as in thickly settled industrial and urban areas. Massachusetts and New York each spend over a half million dollars annually on their cancer programs. A few states spend nothing at all.

CANCER HEALTH EDUCATION

The National Cancer Institute has collaborated with the American Society for the Control of Cancer in the preparation of educational films and posters. Under the law, the Institute is authorized to make available information about cancer through appropriate publications for the benefit of health agencies, physicians, and scientists, and the general public. Under this authority, cancer education becomes an integral part of the general program of health education of the United States Public Health Service.

In cancer health education, periodic physical examinations, early diagnosis, and prompt treatment have been stressed for a long time. Even today we can add little to what Celsus, at the dawn of the Christian era, wrote: "Only the beginning of a cancer admits of a cure; but when 'tis once settled and confirmed, 'tis incurable and the patient must die under a cold sweat." This means that every cancer passes through a curable stage. It may also be said that *when* cancer is treated is more important than *how* it is treated, provided the patient is in competent hands. Indeed, it has been estimated that at least one-fourth of the 163,000 annual deaths from cancer in the United States could be prevented if physicians and the public took full advantage of our present knowledge of the disease. The recent establishment of cancer-prevention clinics in New York, Philadelphia, and Chicago bids fair to be an important step in cancer control. The American Society for the Control of Cancer has reported that "in New York City, of 1,500 women examined in 2 prevention clinics, 7 per cent have been found to have early cancer. Ninety-eight per cent of these women are alive and show no signs of recurrence after suitable treatment." These prevention clinics will, we believe, rapidly increase in number in the postwar period.

RESEARCH ACTIVITIES

Under its authorization to review and recommend applications for grants-in-aid, the National Advisory Council during the past five years has recommended that over $400,000 be paid to various institutions for research upon various approaches to the cancer problem. Large sums have been given to the University of California and a smaller amount to Washington University for support of the construction of cyclotrons. These expensive instruments produce the well publicized neutron rays and the radioactive "tracer" elements, both of which are being widely employed in experimental biology and medicine.

Inasmuch as cancer of the stomach accounts for about 25 per cent of all deaths from cancer, a co-ordinated effort has been made by the Council to encourage the investigation of the causes, diagnosis, and treatment of gastric cancer through substantial grants to certain carefully selected institutions, where facilities and expert personnel seem to warrant such studies. These investigations involve the relationship of chronic gastritis, atrophic gastritis, and gastric ulcer to the genesis of gastric cancer, and also studies to facilitate the early diagnosis of cancer by means of the gastroscope and improved gastroscopic technics. As yet it is too early to evaluate these researches. Clear-cut results cannot be expected in a short time.

Research at the National Cancer Institute proper is not departmentalized. There are no subdivisions of biochemistry, biophysics, genetics, cytology, etc., but we do have men on the staff highly trained in each of these various disciplines. Staff members work together in groups according to the need and requirements of a specific problem. Such a group is not like a "committee"—seldom has a "committee" discovered anything. Our staff members work separately at their own benches with their hands, but at the same time they work together with their heads in discussion groups when results and experiences are pooled.

It is believed that cancer research, like cancer therapy, can no longer be left exclusively to the isolated individual worker. In fact, it has been stated by a prominent cancer investigator that for the past two decades no important contribution to our knowledge of cancer has come except through the efforts of those who have worked systematically as members of organized research groups. We believe strongly in responsible co-operative efforts which arise spontaneously in response to the felt needs of the individual workers in contrast to enforced co-operation or regimentation from the top. Effective and productive co-operation in research can be secured best through mutual consent and mutual need.

STUDIES IN CARCINOGENESIS

Since 1939, when the National Cancer Institute building was completed and occupied, our more significant research achievements have been in the field of carcinogenesis. The transition of normal cells to cancer cells has been carefully followed *in vivo* and *in vitro*. In both instances, carcinogenesis was brought about without visible evidence of inflammation of any sort.

The evidence also seemed to suggest that the transition is gradual. Grady and Stewart (1), of our staff, injected methylcholanthrene or 1,2,5,6-dibenzanthracene subcutaneously into inbred strain A mice. Eighty-five per cent of the mice of this strain will develop lung tumors spontaneously at the age of eighteen months. By killing some of the animals each week and carefully studying the histology of the lung, it was found that the first microscopic evidence of tumors appeared in five and six weeks after inoculation. The tumors arose from the alveolar epithelium and not in the bronchi. They were not associated with any inflammatory reaction.

Shimkin (2) has shown that, despite the presence of chronic irritation induced with a single injection of 5 mg. of four metallic ores including quartz (particle size 1.6 to 3.5 micra), no pulmonary tumors were induced in strain A mice within six months after administration. The intravenous injection of these ores did not increase the number of primary pulmonary tumors, nor did it apparently have any other effect upon the development of such tumors following the intravenous injection of 20-methylcholanthrene.

By following the *in vitro* transition, also, of normal to cancer cells, it is believed that a great deal more light has been thrown on the mechanism of the cancer process. It has been known for many years that certain chemicals when injected into experimental animals would induce tumors. It was not known whether these chemicals induced cancer by a direct action on the cell or indirectly by first setting up some unknown systemic condition or chemical imbalance, which finally brought about malignant growth. If the action is direct, what is the nature of the change from a normal to a malignant cell?

Earle (3) has grown normal mouse connective-tissue cells (fibroblasts) in flasks, following essentially the Carrel technic. These tissue-cell cultures multiply in an entirely foreign culture medium and receive no materials whatever from mice. Thus removed from all systemic influences of the mouse, they were subjected to treatment with 20-methylcholanthrene in different concentrations and for different times. These studies have not been completed, but the following conclusions al-

ready seem to be justified: (1) Normal connective-tissue cells grown artificially outside the animal body in the presence of small amounts of methylcholanthrene change over to malignant cells, as determined by the induction of typical cancers following injection of the cells into mice of the same strain from which the cells were originally obtained. (2) The transition is accompanied by certain changes in morphology of the fibroblasts, and also in physiologic behavior as measured by enzyme and metabolic determinations. (3) These changes take place gradually, and the degree of the change can be controlled by the time of exposure of the cell cultures to the carcinogenic agent.

If these results can be repeated, it means that the transition of a normal to a cancer cell can be brought about by means of changes in the cell itself and is not dependent upon systemic factors. These results with tissue cultures seem also to exclude bacteria as causative agents in the genesis of cancer, although they do not exclude the activation of a latent tissue virus. Up to the present, however, there is no convincing evidence of the presence of filtrable virus agents in mammalian cancer cells.

Experiments with carbon tetrachloride seem to throw further light on the mechanism of carcinogenesis. Earlier work of Edwards and Dalton (4) showed that when 0.12 c.c. of carbon tetrachloride was administered to strain A mice in three doses no hepatomas resulted; but when this total quantity was given in twenty-five doses, two or three days apart, hematomas developed in an appreciable number of animals. Subsequently, Eschenbrenner[3] found that when carbon tetrachloride was fed daily to a group of strain A mice for thirty days, no hepatomas developed. Other groups of mice were given the same total dosage, but one group received successive doses every second day, another group every third day, another every fourth day, and the last group every fifth day. Of those that received the carbon tetrachloride every fourth or fifth day, a high percentage had hepatomas. It was found, in addition, that varying the size of successive doses so that the largest was 16 times the smallest had no effect. Thus it seemed that the dosage interval or longer chronicity of exposure to the agent was more important in the genesis of this type of liver cancer than was the total dosage. In those animals in which the hepatomas had developed, carbon tetrachloride, when again administered, produced no necrosis of the hepatoma cells, but definite and widespread necrosis was observed in the normal liver cells from which the cancer cells arose. In view of this, one can say that the genesis of cancer of the liver in mice seems to be intimately associated with the process by which cells become adjusted to unfavorable environments. The role of the adjustment process, however, is not so clearly seen in cancers following single injuries or exposures. Nevertheless, it may be present.

Henshaw[4] has shown that the incidence of leukoses has been increased in three different strains (C3H, C57 Brown, and C57 Black) of inbred mice by whole-body exposure to 200-kv. x-rays. Such increase was obtained by single acute doses of 200 to 400 r, but even greater increases were obtained by repeating the treatments at intervals of one month. Blum, Grady, and Kirby-Smith (5) have shown that when mice are irradiated with ultraviolet light, the tumor-induction time does not vary significantly with intensity of radiation, but it is shorter when the same total dose is given in smaller, more frequent exposures.

In this same connection, the writer (6) has shown that, when various strains of bacteria are permitted to multiply continuously by daily transfers and are kept at temperatures well above the optimum, the species becomes gradually weaker and finally dies. On the other hand, when the organisms are exposed alternatingly rather than continuously to the same high

[3] Material not yet published.

[4] Unpublished work.

temperatures, the species not only survives but is soon able to withstand higher temperatures. The alternating exposure has thus resulted in a successful adjustment to an unfavorable environment.

Is the genesis of cancer always the result of a process of successful adjustment of cells to some unusual environmental condition? This question cannot be answered at present with any degree of finality, but all of the observations cited seem to fit in with this concept.

The National Cancer Institute has only lately undertaken investigations in the field of cancer therapy. Some work is also being done along the line of development of reliable diagnostic tests in the early stages of the disease, but no outstanding results have yet been achieved. Our studies in carcinogenesis are regarded as basic because they may eventually lead both to diagnostic methods and rational therapy. Other approaches to the problem, such as the role of vitamins and other nutritional factors in cancer and in normal tissue, the role of hormones and of enzymes, and the characterization of the metabolism of normal and of cancer tissue, are, of course, being followed. Time and space do not permit a detailed discussion of these activities at the present time.

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CASE REPORTS

Traumatic Hernia of the Lateral Pharyngeal Walls[1]

CAPT. WALTER D. HANKINS, M.C., A.U.S.

The following case is recorded because of its unique character. A search of the medical literature failed to reveal any similar example.

Wm. C. W., a 26-year-old sergeant, a trumpet player in the regimental band, was admitted to the Station Hospital, Fort Banks, Mass., for psychiatric study.

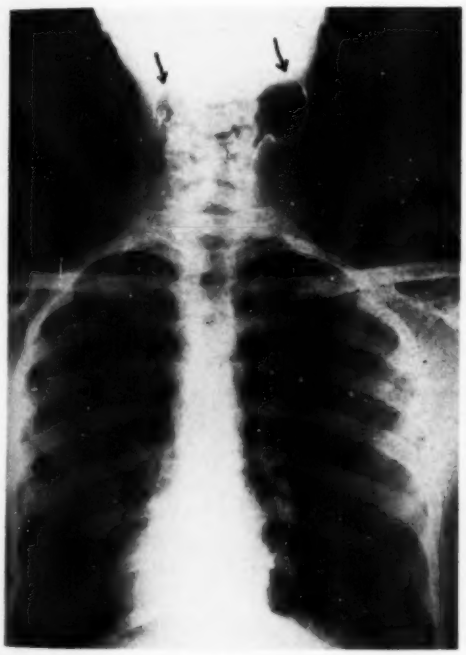

Fig. 1. Anteroposterior view showing dilated lateral walls of the pharnyx outlined with barium.

An incidental but interesting finding was a bulge, the size of an egg, in the right cervical region, just below the angle of the mandible, appearing when the patient closed his mouth and blew, as in playing a trumpet.

About six months prior to admission, while blowing his trumpet, the patient felt something "give way" in the right side of his neck. Ever since he had noticed a bulge at this point when he played. Each time after blowing on his instrument, his neck would be sore and swallowing would become painful. He had a horseshoe-shaped piece of metal made with pads on each side which fitted around his neck to keep the muscles from herniating, but this afforded only slight relief.

When the patient blew against pressure, radiographic and fluoroscopic examination showed the hypopharynx filled with air and a bulge of the neck muscles laterally. The piriform sinuses were filled with air and the weakened muscular walls bulged laterally on both sides above the level of the larynx. The right side was dilated more prominently. The lateral walls of the pharynx were outlined with barium. The posterior wall of the trachea, just below the larynx was also weakened and bulged posteriorly upon the esophagus. The apices of the lungs rose above the clavicles and in the lateral view can be seen superimposed on the lower portion of the trachea.

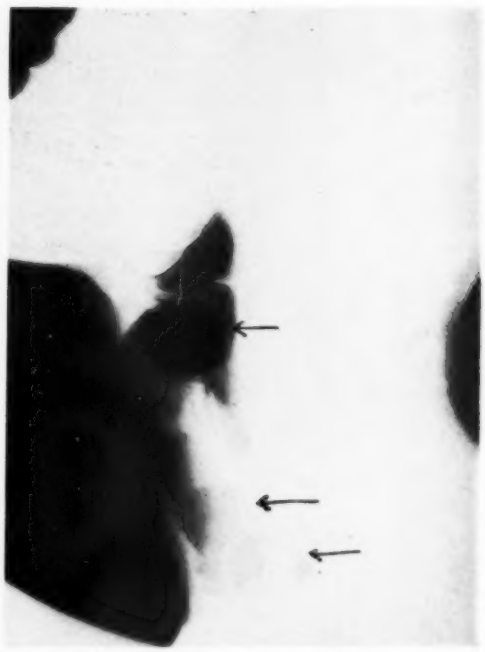

Fig. 2. Lateral view. Upper arrow indicates air in dilated pharynx; middle arrow tracheal dilatation posteriorly; lower arrow apex of the lungs above the level of the clavicles.

[1] From Station Hospital, Fort Banks, Mass. Accepted for publication in September 1943.

Cushing General Hospital
Framingham, Mass.

Foreign Body (Bottle) in Rectum[1]

STANLEY H. MACHT, M.D.

Philadelphia, Pa.

The following case is considered of sufficient interest to merit addition to the increasing list of medical curiosities. The unusual nature of the foreign body stimulated our interest in searching the literature for similar oddities. The reader is referred to the appended bibliography for equally interesting cases.

C. K., a white American sailor, aged 31, entered the accident ward, Jan. 24, 1943, complaining of pain in the lower abdomen, inability to have a bowel movement, and bleeding from the bowel on attempting defecation. On the preceding day he had drunk himself into an alcoholic coma and remembered no more until the morning of admission. At that time he made several attempts to satisfy an overwhelming desire to defecate but was unsuccessful. On "bearing down" he observed a trickle of blood from his rectum. Through self examination he felt a hard object inside the anal orifice.

Through a rectal speculum the bottom of a bottle was seen approximately 3 cm. from the anal orifice. The abdomen was tender. Pain was aggravated by deep breathing, coughing, and sneezing.

Roentgenographic examination showed the bottle to be in the sigmoid and iliac colon with its open end pointing upwards. Calculi were also noted in the gallbladder area.

Under spinal anesthesia the bottle was extracted manually by Dr. J. Surver of the Department of Surgery. The anus was dilated and all of the fingers of one hand could be placed inside of the rectum to grasp the bottle and effect its removal.

Following the "delivery" the abdomen remained tender for three days but there was no elevation of temperature or pulse rate. In a week all symptoms subsided and the patient was discharged.

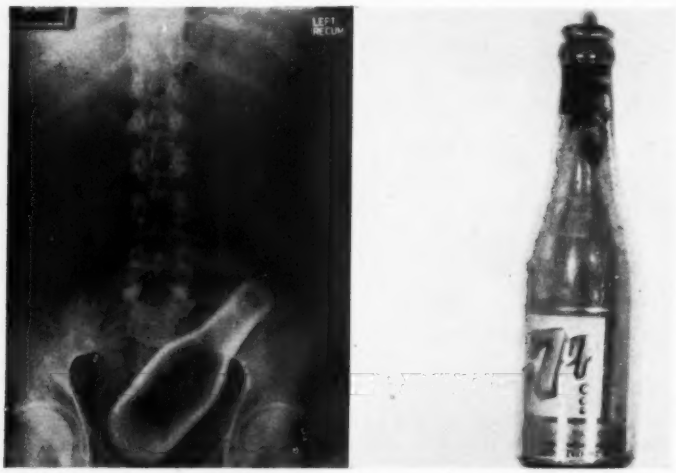

Fig. 1. Foreign body in the rectum.

A review of the literature on foreign bodies in the rectum shows this to be the eighth recorded case in which a bottle was present (1, 2, 3, 4, 19). The most remarkable among the foreign bodies reported in the literature up to the present date are: a snuff-box (1); whiskey glasses (1, 5, 6, 7, 17, 18); a 30-cm. mortar pestle (1); ox horns (1, 8); electric light bulbs (9, 10); an ink bottle (11); a vaseline bottle (12); a cold cream jar and lemon (13); an apple (14); chicken bones (15); glass tube (16); portion of a broom handle (17); frozen pig's tail (1); tool box containing a piece of gun barrel, a screw driver, two hacksaws, a boring

[1] From the Department of Roentgenology, Jefferson Hospital, Philadelphia. Accepted for publication in November 1943.

syringe, a file, several coins, thread and tallow (1). The tool box and its contents were removed from a prisoner who made his escape through death from obstipation. At autopsy the tool kit was found to have migrated into the transverse colon.

Some of the methods of extracting these foreign bodies have been most ingenious. In the case of the pig's tail, held in the anus of a French prostitute by shortly cropped bristles, the passage of a lubricated hollow willow, into the anus around the foreign body, with subsequent removal of both willow and tail, speaks well for the ingenuity of 16th-century surgeons. In more recent years the larger foreign bodies of glass have on occasion been cracked into smaller bits by touching with a hot cautery tip after visualization through a speculum. Swabs chilled in ice water were then applied directly to the heated glass. Another method of removing bottles or glasses consists in packing into the open end of the glass long strips of gauze dipped in plaster of paris paste. A long end is left free outside of the anus to afford traction after the plaster hardens inside of the foreign body.

SUMMARY

A case of an unusual foreign body has been added to the list of those now recorded in the literature. A brief summary of other outstanding case reports is made.

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EDITORIAL

Howard P. Doub, M.D., Editor

John D. Camp, M.D., Associate Editor

Osteoid-Osteoma

The term osteoid-osteoma was introduced in 1935 by Jaffe (1) to designate a "benign osteoblastic tumor composed of osteoid and atypical bone," formerly undescribed. He reported, at that time, 5 cases, all of them diagnosed preoperatively as inflammatory lesions—chronic osteomyelitis or bone abscess—and discussed the clinical, roentgenologic, and pathologic features by which the newly discovered tumor might be recognized.

Even before the publication of his original communication, Jaffe encountered further cases, and by 1940 the number had increased to 33. These form the basis of a paper by Jaffe and Lichtenstein, (2) representing their experience up to that time. It was clearly shown that the disease has a predilection for adolescents and young adults. Age records were available for 30 patients and all but 5 of these were between eleven and twenty-four years of age. The lesions were found in the bones of the limbs and of the vertebral column, but none was encountered in the flat bones of the pelvis, skull, or ribs.

Jaffe's early impression was that the osteoid-osteoma began its development in spongy bone, and his original paper carried a statement to that effect. His subsequent experience, however, showed that it may also have its origin in the cortex, more especially on the periosteal or medullary surface. Lesions originating in spongy bone show an associated area of perifocal osteosclerosis; they may lie deep in the bone or may be more superficial, especially in the small bones consisting mainly of spongiosa. In such cases the cortical shell may be eroded and the periosteum elevated. When the osteoid-osteoma arises in the cortex, there is usually a more extensive reaction. Developing along the outer surface of the cortex, the lesion may be accompanied by a marked periosteal reaction, with a considerable deposition of new bone. When it develops on the medullary surface, there is also new bone formation, sometimes of such degree that the marrow cavity is obliterated for some distance above and below the lesion. An occasional case appears to be periosteal in origin with little reaction in the underlying cortex.

In the series studied by Jaffe and Lichtenstein the principal complaint was of pain, and it was this that usually brought the patient to a physician. At first mild and periodical, it later increased in persistence and severity so as to interfere with sleep. There were usually some swelling and tenderness over the painful area. There was an absence of local heat and redness which was all the more noticeable because most of the cases were thought clinically to have an inflammatory basis, such as chronic osteomyelitis.

Jaffe and Lichtenstein believe that the diagnosis is not difficult. It should be suspected if (1) the patient is an adolescent or a young adult, (2) the complaint is of well localized bone pain of at least two months' duration, (3) the pain is not associated with local heat, although some local swelling may be present, (4) the condition is not, and has not been, accompanied by bouts of fever.

The greatest single diagnostic aid is the roentgenogram of the affected area. In its earlier course the lesion is indicated by an area of bone radiolucency, which may vary in diameter from 0.5 to 2.0 cm.,

with an average of 1.0 cm. It is likely to be round if situated in spongy bone and oval if in the cortex of a long bone. It is usually surrounded by a zone of reaction which may range from a slight increase in bone density to a dense shadow with loss of all details of bone structure. This area of density may vary in width from a narrow ring to one several centimeters in width. In the cortex of a long bone it may be demonstrable for several inches above and below the area of lessened density and may extend around the circumference of the affected shaft.

In its later stages the osteoid-osteoma tends to become more densely calcified and the appearance is less uniform. In a spongy bone area it is likely to appear as a dense circular circumscribed shadow, often surrounded by a narrow zone of lesser density. In the shaft cortex of a long bone the density of the secondary reaction may be so great that the opaque nidus representing the primary lesion may be missed on an ordinary exposure and an overexposed film of the area may be necessary for its demonstration.

Jaffe and Lichtenstein believe that the osteoid-osteoma is a benign osteogenic tumor of slow growth. Its initial stage appears to be a proliferation of the local bone-forming mesenchyme, particularly of its osteoblasts. Considerable intercellular substance subsequently develops between the osteoblasts and, as this slowly calcifies, numerous osteoid trabeculae appear. Later the tumor becomes more densely calcified and eventually is composed of compact trabeculae of atypical bone, the intertrabecular tissue of which is vascular and may still be rather cellular in some places. Ultimately the osteoma aspect is more prominent than the osteoid aspect.

Surrounding the osteoid-osteoma in spongy bone there is usually a narrow zone of vascular connective tissue, which in turn is surrounded by dense osseous tissue. The trabeculae composing this are thick and irregular and interspersed with fibrous marrow. In the shaft cortex the reaction may be extensive, the thickened cortex consisting of two layers—one representing the original cortex and around this a layer of compact newly deposited periosteal bone.

Since the publication of Jaffe's original paper, a number of reports of this lesion have appeared in medical literature. Horwitz (3) in 1942 described a typical osteoid-osteoma of the astragalus. A case involving the femur was presented by Kleinberg (4) in 1941. In this instance the nidus was entirely within the cortex. A case record from the Massachusetts General Hospital (5) describes an osteoid-osteoma of the tibia at the junction of the upper and middle thirds. These are only a few examples of a growing literature on the subject.

Surgery is the usual method of therapy. Resection of the lesion, with curettage of the perifocal bone, has effected prompt clinical cure in these cases.

If the contention of Jaffe that this lesion is a benign bone tumor is upheld by further study, it is entirely probable that many cases which have been diagnosed as inflammatory bone lesions have been in reality neoplastic—*i.e.*, osteoid-osteomas. This is especially true of those cases which have been designated "sclerosing non-suppurative osteomyelitis," "osteomyelitis with cortical bone abscess," etc. It will be well for the radiologist to study carefully the clinical and roentgenologic findings in cases presenting the criteria described, to the end that these may be correlated with the pathologic findings and a general agreement may be reached regarding the nature of this lesion.

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JOINT MEETING
AMERICAN ROENTGEN RAY SOCIETY
and
RADIOLOGICAL SOCIETY OF
NORTH AMERICA

Attention is again called to the joint meeting of the American Roentgen Ray Society and the Radiological Society of North America to be held in the Palmer House, Chicago, Sept. 24 to 29, 1944, announcements of which appeared in the March and April issues of RADIOLOGY.

Titles and abstracts of papers to be presented should be submitted to Dr. Lyell C. Kinney (1831 Fourth Ave., San Diego 1, Calif.) or Dr. Eldwin R. Witwer (Harper Hospital, Detroit 1, Mich.) before July 1. Prospective commercial exhibitors should make application for space to Dr. Lawrence Reynolds (10 Peterboro, Detroit 1, Mich.), and those planning to present scientific exhibits should communicate with Dr. Clarence Hufford (421 Michigan St., Toledo 2, Ohio) at the earliest possible date.

An outline of the Refresher Courses, which will begin Sunday, Sept. 24, will appear in an early issue of RADIOLOGY.

CHICAGO ROENTGEN SOCIETY

At the Annual Meeting of the Chicago Roentgen Society, April 13, 1944, the following officers were elected: President, Warren W. Furey, M.D.; Vice-President, T. J. Wachowski, M.D.; Secretary-Treasurer, Fay H. Squire, M.D. (Presbyterian Hospital, 1754 W. Congress Street, Chicago 12); Trustees, Earl E. Barth, M.D., Frank L. Hussey, M.D., and Benjamin D. Braun, M.D.

In Memoriam

JAMES MORTIMER HOFFMAN, M.D.
1900–1944

Dr. James Mortimer Hoffman, of Pensacola, Fla., died on Jan. 19, 1944. Doctor Hoffman was a graduate of Tulane University of Louisiana School of Medicine. He was a member of the Radiological Society of North America, the American College of Surgeons, the Southeastern Surgical Congress, and the South Atlantic Association of Obstetricians and Gynecologists.

ONAL ARTHUR SALE, M.D.
1891–1944

Dr. Onal Arthur Sale of Neosho, Mo., died on Jan. 27, 1944. Doctor Sale was graduated from the Medical Department of the National University of Arts and Sciences, St. Louis, in 1917. He was part owner and medical director of the Sale-Bowman Hospital of Neosho. He had been a member of the Radiological Society of North America since 1928.

Books Received

Books received are acknowledged under this heading and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

EXPLORACIÓN RADIOLÓGICA DEL BRONQUIO. By S. DI RIENZO. Preface by RICHARD H. OVERHOLT, M.D. A volume of 340 pages, with 417 illustrations. Published by Sebastián de Amorrortu e Hijos, Córdoba 2028, Buenos Aires.

Book Reviews

ROENTGENOGRAPHIC TECHNIQUE. A MANUAL FOR PHYSICIANS, STUDENTS, AND TECHNICIANS. By DARMON ARTELLE RHINEHART, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas; Roentgenologist to St. Vincent's Infirmary, Missouri Pacific Hospital, and the Arkansas Children's Hospital, Little Rock, Arkansas. A volume of 471 pages with 201 engravings. 3d edition, thoroughly revised. Published by Lea & Febiger, Philadelphia. Price $5.50.

This is the third edition of a well-established textbook on roentgenographic technic. The general plan remains the same as in the earlier editions, but the text has been thoroughly revised to include the newer developments which have marked the progress of this specialty since the last edition. About 40 pages and 31 new illustrations have been added, increasing the number of pages to 471.

After discussing the construction and mechanics of roentgen-ray machines in general and their operation, the author takes up the general properties of x-rays. A chapter is devoted to the dark-room and another to the description of a basic roentgenographic technic which can be applied to any machine by the use of experimental exposures and charting the results of actual diagnostic exposures.

The latter half of the book is devoted to the procedures used for roentgen studies of the various parts of the body and concludes with a chapter containing sections on foreign body localization, roentgenography in pregnancy, and the examination of discharging sinuses. Numerous illustrations supplement the descriptions in the text.

The book is well printed and bound. It should be of great value to all those interested in producing better films and can be recommended to physicians, technicians, and students.

PHYSICAL FOUNDATIONS OF RADIOLOGY. By OTTO GLASSER, Ph.D., Professor of Biophysics and Head of Department of Biophysics, Cleveland Clinic Foundation, Cleveland, Ohio; EDITH H. QUIMBY, Sc.D., Associate Professor of Radiology (Physics), College of Physicians and Surgeons, Columbia University, New York; LAURISTON S. TAYLOR, Ph.D., Chief of X-Ray Section, National Bureau of Standards, Washington, D. C.; and J. L. WEATHERWAX, M.A., Philadelphia General Hospital and Graduate School of Medicine, University of Pennsylvania, Philadelphia. A volume of 426 pages with 95 illustrations and numerous depth-dose tables. Published by Paul B. Hoeber, Inc., New York. Price $5.00.

The general quality of this book is such that one would hardly think it a wartime publication. The cloth binding is excellent, the paper good, and the printing remarkably clear and neat. The annoying typographical errors with which many present-day books are liberally sprinkled are entirely absent; the only minor slip of this sort which came to our attention is on page 211, where the symbols D_a and D_s are interchanged with their definitions.

In subject matter, the book combines an elementary text with a collection of tables useful in radiology. These tables are collections of all of the commonly used constants of radiological calculations for voltages between 44 kv. and 180–200 kv., with some data for higher voltages. Absorption of the general radiation in appropriate filter material, back-scatter and depth dose derived from both skin dose and air dose, protection values of various materials, and the latest values of absorption coefficients, are examples of the material presented in a useful form.

THE RADIOLOGY OF BONES AND JOINTS. By JAMES F. BRAILSFORD, M.D., Ph.D., F.R.C.P., F.I.C.S., Hunterian Professor, Royal College of Surgeons, England, 1934–35, 1943–44; First President of the British Association of Radiologists; Radiological Demonstrator in Living Anatomy, The University of Birmingham; Honorary Radiologist to the Queen Elizabeth Hospital, Birmingham; Honorary Radiologist to the Royal Cripples' Hospital and the Warwickshire Orthopaedic Hospital; Radiologist to St. Chad's Hospital, the City of Birmingham Infant Welfare Centres and the Military Hospital, Hollymoor, Birmingham; Consulting Radiologist to the City of Birmingham Hospitals, the Robert Jones and Agnes Hunt Orthopaedic Hospital, the Birmingham Accident Hospital and Rehabilitation Centre, the Birmingham Mental Hospital; Late Radiologist, the Birmingham War Hospitals and Ministry of Pensions Hospitals. Awarded the Robert Jones Gold Medal and Prize of the British Orthopaedic Association, 1927, the Roentgen Prize, 1936. Third Edition. A volume of 440 pages with 404 illustrations. Published by J. & A. Churchill, Ltd., London, 1944. Price 45*s*. ($9.00).

Since 1934, when the first edition was published, this book has taken its place among the standard works of reference on the roentgenologist's shelf. No other single volume packs between its covers so much reliable information concerning the roentgenology of the skeleton.

In this, the third edition, much new material has been added and much of the old has been brought up to date. The general plan of the book has not been changed. It is divided into two sections, the first of which deals in detail with each anatomic division of the skeleton and the second with certain abnormalities and diseases from the standpoint of the skeleton as a whole. Some idea of the amount of new material may be gained from consideration of the fact that more than 300 references have been added to the bibliography. The excellent index continues to be one of the features of the book.

Because of wartime restrictions, the publisher has been forced to use a poor grade of paper except for those pages on which roentgenograms are reproduced. This not only detracts from the appearance of the book but also causes a certain amount of confusion in the order of the illustrations. Line drawings, of which there are many, conform in location to the text, but reproductions of roentgenograms are grouped together on pages of glossy paper and are of necessity out of their regular sequence. This confusion, however, amounts only to a minor inconvenience; the quality of the illustrations continues to be excellent.

Except for the unavoidable lowering of physical quality, the book maintains the high standard of excellence set by previous editions. It is recommended highly for students and roentgenologists alike.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill.

Section on Radiology, American Medical Association.—Secretary, J. T. Murphy, M.D., 421 Michigan St., Toledo, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Martha Mottram, M.D., Suite 1789, 450 Sutter St., San Francisco. Meets monthly on third Thursday at 7:45 P.M., in Toland Hall, University of California Hospital, from January to June; at Lane Hall, Stanford University Hospital, July to December.

COLORADO

Denver Radiological Club.—Secretary, Edward J. Meister, M.D., 366 Metropolitan Bldg. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford. Meetings bimonthly, on second Thursday.

FLORIDA

Florida Radiological Society.—Acting Secretary, Walter A. Weed, M.D., 204 Exchange Building, Orlando.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Warren W. Furey, M.D., 6844 S. Oglesby Ave. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, M.D., Louisville City Hospital, Louisville. Meeting annually in Louisville, third Saturday afternoon in April.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at the offices of the various members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St. Meetings are held the third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, John P. Medelman, M.D., 572 Lowry Medical Arts Bldg., St. Paul. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

The St. Louis Society of Radiologists.—Secretary, E. W. Spinzig, M.D., 2646 Potomac St. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary, F. L. Simonds, M.D., 1216 Medical Arts Bldg., Omaha. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary,* Hugh F. Hare, M.D., Lahey Clinic, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. J. Perlberg, M.D., Trust Co. of New Jersey Bldg., Jersey City. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called by president.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave. Meetings held the fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St. Meetings second Monday evening each month, October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Haig H. Kasabach, Presbyterian Hospital, New York, N. Y.

Rochester Roentgen-ray Society.—Secretary, S. C. Davidson, M.D., 277 Alexander St. Meetings at convenience of committee.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, J. E. McCarthy, M.D., 707 Race St., Cincinnati. The next meeting will be held at the time and place of the annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport. The Society meets annually.

The Philadelphia Roentgen Ray Society.—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22nd St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Reuben G. Alley, M.D., 4800 Friendship Ave., Pittsburgh, Pa. Meetings are held on the second Wednesday of each month at 4:30 P.M., from October to June, at the Pittsburgh Academy of Medicine, 322 N. Craig St.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston. Meeting in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Texas Radiological Society.—Secretary-Treasurer, Herman Klapproth M.D., Sherman.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

La Société Canadienne-Française d'Eléctrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Skeletal System

Gynecology and Obstetrics

The Genito-Urinary Tract

Venography

Foreign Bodies

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Tuberculosis of the Flat Bones of the Vault of the Skull. A Study of 40 Cases. C. M. Meng and Y. K. Wu. Chinese M. J. **61:** 155–171, April-June 1943.

Tuberculosis of the skull is not an unusual disease in those areas where the incidence of tuberculosis is high. From 1926 to 1940 inclusive, more than 70 cases of cranial bone tuberculosis were diagnosed clinically at the Peiping Union Medical College Hospital. Diagnosis was established in 20 cases histologically, in 5 cases by animal inoculation or culture, and in 15 cases by clinical, roentgen, and other laboratory findings. These 40 proved cases were used for statistical study. Twenty-three of the patients were males. Eighty per cent were less than twenty years of age. Local trauma was not found to be an important factor.

The authors believe that primary tuberculosis of the skull is rare. In 85 per cent of their series of 40 cases, active foci were present elsewhere; pulmonary lesions were demonstrable in 18 cases. Coexistent lesions were found in the mandible and other facial bones in 9 cases, in the sternum in 5 cases, the scapula in 4 cases, and the pelvis in 3 cases

The tubercle bacilli are believed to be blood-borne, lodging in the diploe and then involving both tables of the skull. Occasionally they may invade the bone via the periosteum or the dura. Two clinical types of lesion are described. The circumscribed, perforating, solitary type was most common in this series, occurring in 38 cases. The defects varied from a few millimeters to 2 cm. in diameter, were round, oval, or irregular in form, and contained sequestra or bone sand. The diffuse or infiltrating type of lesion occurred in only 2 cases. This is believed to spread through the diploe, producing multiple perforations. In either type, with perforation of the outer table, a subperiosteal cold abscess forms. This may remain as a small, palpable, firm, non-tender mass for some time, but eventually it may rupture into the subcutaneous tissue and subsequently form a discharging sinus. The dura usually affords excellent protection when the inner table is perforated. No instance of tuberculous meningitis or cerebral tuberculosis was present in this series. The frontal and parietal bones were affected most commonly. In seven cases, a single lesion involved two adjacent bones, indicating that suture lines form no barrier to the disease process.

The onset is invariably insidious, many patients seeking treatment for complaints in areas other than the skull. The swelling is painless unless secondarily infected and is often mistaken for a sebaceous cyst or lipoma. Perforation of the skull may be detected by palpation of its bony edge. If the perforation is complete, through both tables, arterial pulsations transmitted from the dura are palpable or actually visible if the lesion is sufficiently large.

Syphilis offers the most difficult problem in differential diagnosis since neither a positive serological or tuberculin test necessarily rules out the other condition. Negative tests are of definite value.

Roentgenography is a distinct aid in demonstrating bony defects but does not afford a definite diagnosis. The usual picture is that of one or more round or oval, punched-out defects in which a sequestrum or bone sand may be seen. There may be no peripheral bone reaction or there may be a zone of increased density as much as 2 cm. in width. Although the lesions are usually osteolytic, osteoplastic changes may occur discharging sinuses or secondary infection.

When possible, aspiration, for culture and animal inoculation purposes, and biopsy should be performed to establish a positive diagnosis.

Prognosis depends on the degree of tuberculous involvement and general condition of the patient. In early cases the prognosis may be fair even in the presence of multiple associated lesions.

Local treatment consists of complete excision of the diseased tissues and closure without drainage except when there has been a discharging sinus or ulcer. The dura should not be disturbed. Radiation therapy was used in 3 cases (in 2 postoperatively) with good results and is recommended especially in the larger lesions not suitable for excision.

Photographs and roentgenograms are reproduced.

LESTER M. J. FREEDMAN, M.D.

Fractures of the Zygoma: Report of 72 Consecutive Cases. Walter A. Coakley and Malvin F. White. Surg., Gynec. & Obst. **77:** 360–366, October 1943.

Fractures of the zygoma have been neglected in medical literature in recent years, probably because they are not treated by any one group of specialists, but by various groups in different clinics. This report deals with 72 consecutive cases seen in Kings County Hospital (Brooklyn, N. Y.) from July 1939 to June 1942. In that hospital all such cases are treated by the Plastic and Oral Surgical Service, but only 29 per cent of the series under consideration were originally admitted to that service. Two-thirds of the patients were seen initially in the Neurosurgical Service because of head injuries or for neurological observation. For this reason it is especially important that neurosurgeons be acquainted with this lesion.

Fractures of the zygoma are always due to trauma. In the authors' series 31 cases were due to automobile and trolley accidents, 16 cases to fist blows, 8 cases to falls, 5 cases to a blow from a foreign object; in 12 cases the type of injury could not be determined.

The average age of the group was 32.4 years, the youngest patient being 14 years of age, and the oldest 65. Fifty-seven of the series were males. There were 5 cases of bilateral fracture; but in the remainder the ratio of left to right was almost 3.5:1. These fractures are usually multiple, and in only 4 cases did a single fracture exist. The average was 3 fractures each, the total number of fractures being 207 in the 72 patients. The arch was the most frequent site, with the infraorbital region coming next.

The most frequent signs and symptoms are as follows: periorbital swelling and ecchymosis, local tenderness, palpable depression or irregularity, pain (either constant or on chewing), asymmetry of the face, epistaxis, and sensory changes over the distribution of the infraorbital nerve. Almost all of the patients had lacerations and contusions of the face, and many of them had fractures of other facial bones.

All of the patients in this series requiring operation were operated on within two weeks of the injury, and

most of them within the first week. Two methods of approach are used. The first of these is the temporal approach which was used where the arch was depressed. This method is unsatisfactory in those cases in which the force of the blow causes the body of the zygoma to be driven downward and into the antrum with lowering of the infraorbital ridge and multiple depressed fragments of the wall of the maxillary sinus. In these an antral approach was employed, through the vestibule of the mouth, as for a Caldwell-Luc operation. A blunt instrument such as a curved urethral sound of medium size was passed in and the fragments were elevated.

Forty-two patients were operated upon, and hemorrhage, in 2 cases, was the sole complication; in both it was controlled by packing. In 24 cases a temporal approach was used, and in 14 an antral approach; 2 patients required a combination of the two methods. In 8 of the 14 cases in which an antral approach was used, packing was required to maintain the reduction. The patients with no other injuries were discharged one to fourteen days postoperatively.

JOHN O. LAFFERTY, M.D.

Adamantinoma: Report of 8 Cases. L. K. Chont Am. J. Roentgenol. **50:** 480–490, October 1943.

Eight cases of adamantinoma are here reported, 7 in the jaw and 1 in the pituitary body. In one of the jaw tumors pulmonary metastasis occurred. A review of the literature revealed only 14 other examples of distant or regional metastasis.

Adamantinomas occur most frequently in the jaws. Several cases of pituitary adamantinoma have been recorded and approximately 16 of the tibia. Whatever the origin of the tumor, it can always be traced back to the parent cell, the oral epithelium. Histologically it is composed of groups of epithelial cells in a stroma of normal connective tissue.

Clinically, adamantinoma of the jaw is characterized by its long duration. It is a painless, slowly growing, centrally located tumor which may reach large size. The roentgen examination is very important in establishing the diagnosis. The solid adamantinoma produces a monocystic appearance on the roentgenogram. It usually can be differentiated from other cysts by the more lobulated borders of the bone defect and the presence of a few fine bone trabeculae at the edges of the lesion. The polycystic type has a honeycomb appearance in the early stage, and later is characterized by huge distention of the bone by a cystic defect showing several rounded compartments. An adamantinoma may form a large single cavity resembling a dentigerous cyst but can be differentiated by the appearance of the margin, as noted above.

Roentgenograms of the reported cases are reproduced and a bibliography is appended. L. W. PAUL, M.D.

Osteoma of the Frontal Sinus. Report of a Case. W. H. Johnston. Arch. Otolaryng. **38:** 318–323, October 1943.

A white woman, 50 years of age, was admitted to the hospital in 1936, complaining of severe headaches. It was thought that pituitary disease might be a factor, and roentgen examination of the sella turcica was made. No consideration was apparently given to the possibility of a sinus condition, and an osteoma, although visible in the roentgenogram then made, was not reported. In August 1942, the patient was again admitted to the hospital, complaining of dizziness and headaches, which had been increasing in severity over the past three months. On roentgen examination a bony structure was seen almost filling the left frontal sinus, apparently arising from its roof. A diagnosis of osteoma of the left frontal sinus was made and later confirmed at operation. The point of attachment of the tumor was at the extreme upper and anterior wall of the sinus, suggesting activation of a periosteal embryonal rest as the etiologic factor. Comparison of the roentgenograms taken in 1936 and 1942 shows a very slight but perceptible increase in the size of the tumor in six years.

THE CHEST

Acute Pneumonitis. Wendell G. Scott and Horace L. Jones, Jr. Am. J. Roentgenol. **50:** 444–452, October 1943.

The diagnosis of acute pneumonitis has become more common in the past two years, largely because of more intensive use of chest roentgenography. Chest roentgenograms were made for 145 of 534 patients admitted to the medical wards at the U. S. Naval Air Station in San Diego with a tentative diagnosis of acute catarrhal fever, which the authors explain is an all-inclusive term covering many types of benign acute upper respiratory infection. Seventy-four of these patients showed areas of pulmonary consolidation of the type referred to as acute pneumonitis.

There is nothing characteristic about the roentgen appearance of the area of pneumonitis that can be considered as pathognomonic of the disease. It is easily identified, however, when occurring in epidemic form among young, robust military personnel. Usually there is an area of hazy density extending out from the hilar region into the lower lung field and occasionally into the mid lung field. Margins are poorly defined in the beginning. As the disease progresses, the area of pneumonitis becomes more dense and larger, with more sharply defined margins. The shape is usually that of a fan or of a rounded area, and the distribution is lobular rather than lobar. With resolution, the density gradually diminishes, and the infiltration becomes mottled, patchy, and more linear in type.

In the authors' series of 74 cases, 52 occurred in the lower and middle lobes, 9 immediately about the hilum, and 5 in the upper lobes; there were 8 cases of bilateral involvement.

The laboratory findings, differential diagnosis, pathological findings, treatment, and clinical aspects of the disease are reviewed and short histories and roentgenograms of 7 cases are furnished. These illustrate the similarity of the cases seen by the authors to those reported by others. The prevalent opinion is that such infections are probably of virus origin and are, therefore, not responsive to chemotherapy. It is probable that many cases are erroneously diagnosed as "grippe," "upper respiratory infection," or "acute catarrhal fever," and that the more frequent use of chest roentgenograms will disclose an even higher incidence of this disease. L. W. PAUL, M.D.

Massive Conglomerate Lesions of Silicosis Differentiated from Pulmonary Neoplasm. Richard A. Rendich and Mortimer R. Camiel. J. Thoracic Surg. **12:** 686–696, October 1943.

In a review of the literature 5 cases were found in which the diagnosis of carcinoma of the lung was made

and the condition proved to be silicosis. In one of these cases a pneumonectomy was done. This patient is described as having a unilateral hilar mass demonstrable roentgenographically, with no nodular lesions elsewhere. On the other hand, Pendergrass has stated that infiltrating or permeating malignant metastases may be of such appearance as to resemble pneumoconiosis of a conglomerate type.

The authors report 2 cases diagnosed clinically and roentgenologically as carcinoma of the lung which proved postmortem to be silicosis, one being complicated by tuberculosis. In both instances the lesions were bilateral and somewhat symmetrical, with one mass larger than the other. In addition to the large conglomerate masses, other nodular lesions were also present. The authors point out in retrospect that the diagnosis of pulmonary neoplasm should not have been made in either case and that the roentgen appearance was much more consistent with silicosis.

A table is presented giving twenty-nine points by which conglomerate silicotic lesions can be differentiated from pulmonary neoplasms both clinically and roentgenologically. HAROLD O. PETERSON, M.D.

Diverticulum of the Right Primary Bronchus. José Arce. J. Thoracic Surg. **12:** 638–641, October 1943.

A case report is presented with reproductions of several roentgenograms illustrating a diverticulum of the right main bronchus arising on a level with the upper lobe bronchus. This was observed by bronchoscopy and also demonstrated by bronchograms. The diverticulum was rather small and connected to the main bronchus by a large opening. The patient had also a hydatid cyst of the right lung, which was removed surgically. The diverticulum was an incidental finding. No review of the literature or bibliography is given.

HAROLD O. PETERSON, M.D.

Chronic Cor Pulmonale. Leo G. Rigler and Phillip Hallock. Am. J. Roentgenol. **50:** 453–460, October 1943.

Cor pulmonale is defined as enlargement of the right side of the heart, with or without failure, initiated by increased resistance to blood flow within the lesser (pulmonary) circulation as a result of pulmonary disease. Such increased resistance to blood flow may be brought about by obliteration of the capillary bed, such as occurs in emphysema or pneumoconiosis, or narrowing of the pulmonary vessels, as in pulmonary arteriosclerosis. Recent studies have indicated that chronic pulmonary heart disease is more common than formerly supposed.

The recognition of chronic cor pulmonale presents many difficulties. The clinician often can only speculate as to the possibility of right ventricular strain unless signs of right heart failure are present. With careful roentgen examination, cardiac involvement in cases of chronic pulmonary disease can be recognized in a large percentage of cases by evidence of enlargement of the right side of the heart. Roentgen studies must be made in all four standard positions. The characteristic findings are due to enlargement of the right ventricle and of the pulmonary trunk. In addition, the major branches of the pulmonary artery may be dilated beyond the normal. Evidences of chronic pulmonary disease may be apparent, such as chronic tuberculosis, silicosis, bronchiectasis, or emphysema. In the case of primary pulmonary arteriosclerosis, these findings in the parenchyma of the lungs will be absent. In their place will be found a much more striking increase in the size of the pulmonary trunk and its major branches, together with a marked increase in size of the pulmonary vessels extending out to the periphery. These accentuated vessels differ from those seen in pulmonary congestion such as attends left heart failure, by the sharpness of their outlines and the lack of cloudy density in the lung parenchyma.

Differential diagnosis of cor pulmonale is not always simple. Acquired mitral valvular disease produces right heart enlargement, but the pulmonary trunk is usually enlarged to a lesser degree; enlargement of the left atrium is usually obvious, and displacement of the barium-filled esophagus may be noted. In this condition, also, pulmonary congestion rather than real dilatation of the pulmonary arteries is likely to be present, producing a more hazy, ill-defined mottling throughout both lungs as compared with the sharply defined shadows of the pulmonary arteries seen in cor pulmonale. In most congenital defects the differentiation is not difficult, especially if the physical findings are borne in mind. Thus, in the majority of instances of patent ductus arteriosus characteristic murmurs are present, of such a nature as to make the diagnosis apparent when the roentgen findings are taken into consideration. The roentgen examination alone, however, may simulate the picture of right heart failure from pulmonary arteriosclerosis. The heart in hyperthyroidism may tend to simulate right heart enlargement.

L. W. PAUL, M.D

Technique for Locating and Identifying Pericardial and Intracardiac Calcifications. Merrill C. Sosman. Am. J. Roentgenol. **50:** 461–468, October 1943.

In searching for intracardiac and pericardial calcification, proper technic of examination is essential. Roentgenoscopy is required, and the observer's eyes should be thoroughly accommodated. The observer must look *through* the heart shadow, searching for dark, dancing shadows which move to and fro with systole and diastole.

Pericardial calcifications are visible as flat segments or irregular placques just inside the heart shadow. By rotating the patient through 180° some point will be found where the calcified areas will be close to the periphery of the heart shadow, indicating their superficial location. A very common location is on the diaphragmatic surface of the pericardium. These shadows move with the heart shadow on respiration and rotation, but may show only slight or no excursion with systole and diastole. This finding always indicates an adhesive pericarditis but not necessarily a constrictive pericarditis.

It is estimated that 10 per cent of patients with rheumatic mitral stenosis will show calcification in the mitral valve roentgenoscopically, while 90 per cent of those with aortic stenosis will show calcified aortic valves on roentgenoscopy. These calcified valves are best demonstrated with the patient in a slight right anterior oblique position and holding a deep breath. After the auriculo-ventricular junction on the left border of the heart has been located, a search should be made *through* the heart on a line 45° from the horizontal from this point downward and medially toward the right cardiophrenic angle. Both valves will be found on

or near this line. As a rule the calcified mitral valve will be found near the apex of the heart and the aortic valve near the base. In the left anterior oblique position, which is especially valuable in differentiating between the two valves, the aortic valve will be found in the middle third of the cardiac shadow and the mitral valve in the posterior third.

The annulus fibrosus of the mitral valve may calcify, appearing as a large J- or U-shaped shadow, as compared to the more irregular nodular shadows of the calcified valve itself. This occurs frequently in elderly persons and is not thought to be of clinical importance.

Calcification in the coronary arteries can be recognized by the technic already described. The most common location is in the circumflex branch of the left coronary, just beneath the pericardium and just below the auriculo-ventricular notch on the left cardiac border. The calcified areas are seen as a faint linear shadow, segmented, with a smooth curve convex upward.

Myocardial calcifications are less common, but massive areas of calcification may occur in old infarcts or old thrombi. These are most frequently found at or near the apex of the heart in the wall of the left ventricle. Endocardial calcification is also rare and its significance is frequently uncertain. Calcification in tumors of the heart has not as yet been recognized by the author during life.

The author adds a brief statement of his own experience covering 294 cases. L. W. PAUL, M.D.

Atrial Septal Defect: Report of Two Cases in Which There Was Recurrent Laryngeal Nerve Paralysis. Herman Erlanger and Samuel A. Levine. Am. Heart J. **26:** 520–527, October 1943.

Two interesting cases of atrial septal defect complicated by recurrent laryngeal nerve paralysis are recorded. In one a diagnosis of patent ductus arteriosus had been made; in the second a substernal thyroid was suspected.

In Case 1, the electrocardiographic examination showed moderate right axis deviation and inverted T waves in Lead IV. The roentgen examination revealed enlargement of the heart, predominantly downward and to the left, marked prominence of the pulmonary conus, dilatation of the intrapulmonary arteries, and slight enlargement of the left auricle posteriorly. Laryngoscopic examination revealed an immobile left vocal cord. The right cord was mobile, crossed the mid-line on phonation, but did not approximate the paralyzed left cord. The left arytenoid cartilage showed no movement on phonation.

In the second case, the electrocardiographic tracing was similar to that in the first. Roentgen examination showed cardiac enlargement, predominantly of the left ventricle, expansile pulsation in a prominent pulmonary artery which projected well beyond the left border of the cardiac silhouette just below the aortic arch, enlarged intrapulmonary branches on the right side, and no demonstrable enlargement of the left auricle. Laryngoscopic examination revealed a paralyzed left cord, but the right cord approximated the left on phonation.

In each case the evidence points to a compression of the recurrent laryngeal nerve between the aorta and the dilated pulmonary artery.

The necessity for accurate diagnosis in congenital heart disease is stressed, especially since a patent ductus arteriosus may call for surgical intervention.

HENRY K. TAYLOR, M.D.

Anomalous Origins of the Posterior Intercostal Arteries from 915 Thoracic Aortas: Their Role in Fractures of the Ribs. Myrtelle M. Canavan. Am. Heart J. **26:** 511–519, October 1943.

The study here recorded of 915 thoracic aortas collected from various institutions was made in an attempt to determine the role of that vessel in fractures of the ribs discovered postmortem in a considerable group of patients in hospitals for mental diseases. These fractures were usually bilateral, involving the fourth to the eighth ribs.

Of the 915 specimens, 473 were from males and 371 from females; for the remaining 71 the sex was not recorded. The majority were from patients in the fourth to the ninth decades, but the lower age groups were also represented. The nine paired intercostal arteries (from the level of the subclavian down to the level of the diaphragm) were found in the normal posterior mid-location in only 231 instances, or 25 per cent of the series (Group I). The remaining aortas (75 per cent) were divided into six groups (II–VII) depending on the prevalent anomaly, as follows: II. Most of the upper vessels arising to the left of the mid-line and the lower ones to the right, 41 or 4.5 per cent. III. Most of the upper vessels arising to the right and the lower ones to the left of the mid-line, 71 or 7.8 per cent. IV. All to the right of the mid-line, 314 or 34.3 per cent. V. All to the left of the mid-line, 168 or 18.4 per cent. VI. All situated anteriorly, 75 or 8.2 per cent. VII. Scattered origins not included in the other groups, 16 or 1.7 per cent.

In 673, or 73.6 per cent of the series, there was an atherosclerosis or arteriosclerosis which narrowed or covered the mouths of the intercostal arteries. In some cases there was a history of alcoholism and in some of syphilis. The pathological changes in the aorta taken in conjunction with the anomalies of origin of the intercostal vessels are believed to have resulted in interference with the nutritional function of the vessels. "If," says the author, "the ribs . . . may be considered to receive their blood supply from the anterior and posterior intercostal arteries, although no text book which I consulted states this as a fact, the majority of them in this group of 915 cases had handicaps." This is regarded as a possible explanation of the perplexing incidence of fractured ribs postmortem which prompted this study. HENRY K. TAYLOR, M.D.

THE DIGESTIVE SYSTEM

Problems in Gastric Diagnosis. The Gastroscope as a Supplementary Aid to X-Ray Examination. Allan L. Cohn and Joseph Levitin. Gastroenterology **1:** 841–854, September 1943.

There are definite limitations to the x-ray diagnosis of gastric lesions. Five per cent of early carcinomas are not demonstrable roentgenologically. Only if an ulcer penetrates the mucosa can it be demonstrated; consequently many acute ulcers are missed. There are no sure x-ray criteria for differentiating malignant from benign ulcers, malignant from benign growths, and intrinsic from extrinsic lesions.

Gastroscopy also has its limitations. There are three blind areas: the lesser curvature of the antrum, the posterior wall near the cardia, and a small area of the mid-portion of the greater curvature. The gastroscope cannot be safely used in the presence of esophageal obstruction, varices, or diverticula, mediastinal tumors or

aneurysm. Its use may be valueless in the presence of lesions of the deeper tissues without mucosal involvement. Gastroscopy, however, often gives information obtainable in no other way. It is especially valuable in the diagnosis of lesions of the mucosa difficult or impossible to detect by roentgenography, as gastritis, granulomata, superficial erosions, and polyps.

In many instances differentiation of the malignant from the benign gastric ulcer is possible roentgenologically. The roentgen appearance of a typical benign ulcer differs from that of the typical malignant ulcer. The essential differential points indicating malignant ulcer are invasion of adjacent tissues, an irregular niche, changes in the surrounding mucosa, and encroachment upon the gastric lumen. Variations in these criteria occur, however, and even a therapeutic test is not infallible.

The gastroscopic appearances, also, differ in benign and malignant ulcers. A benign ulcer appears as a white or yellow smooth depression, round or oval, in an orange red mucosal field. Its edge is quite distinguishable from the surrounding mucosa. A malignant ulcer appears as an irregular depression in the center of an elevation. The floor is irregular, of a dead white, dirty gray, black brown, or purple color. The margin is not sharply defined and may merge into the adjacent mucosa.

Gastroscopy is also useful in distinguishing malignant from benign tumors. It is especially valuable in indicating the extent of a malignant lesion, which cannot be judged from the x-ray appearance. Polyps which are rarely diagnosed by roentgenography can be visualized by gastroscopy and their size and number established.

Gastroscopy is also of great value in determining the origin of gastric bleeding, whether it is due to a surgical condition, requiring immediate attention, or to a nonsurgical cause. It renders assistance in differentiating antral spasm from intra- and extra-gastric lesions. Gastritis of both the hypertrophic and atrophic type can be diagnosed only by gastroscopic examination. The status of the stomach postoperatively can be determined more readily by gastroscopy than by x-ray examination.

Volvulus of the Cecum and Ascending Colon, with a Review of the Literature and Presentation of a Case. Milton Rothman, John P. Bruckner, and Dominick F. Zetena. Am. J. Surg. **60:** 292–297, May 1943.

Volvulus of the cecum and ascending colon occurs infrequently. Six cases of volvulus were encountered in the last 150 cases of acute intestinal obstruction at Harlem Hospital (New York). The case reported here is the only one in which the cecum and ascending colon were involved.

Failure of fixation of the colon in the course of embryological development is the underlying cause of volvulus. The predisposing factors are (1) unusual length of the mesentery; (2) narrow base to the loop of the intestine; (3) a point of adhesion, inflammatory or congenital, at the convexity of the loop which can act as an axis of rotation. The following have been suggested as possible precipitating causes: tumors, direct violence, overexertion, habitual constipation, fecaliths, foreign bodies, and violent peristalsis. Volvulus occurs three times more frequently in the male than in the female. It is generally seen between the third and fourth decades of life.

The symptomatology is essentially that of acute intestinal obstruction. The progression of symptoms, however, is much more rapid in a closed loop obstruction involving the cecum and ascending colon than in a simple obstruction. Chemical studies reveal an elevation of urea nitrogen and low chlorides. The hematocrit shows hemoconcentration. The diagnosis of a strangulated loop is made on the finding of an intestinal obstruction in association with signs of peritonitis.

Roentgenograms are of assistance in the diagnosis of volvulus of the cecum. This is indicated when, in the course of a barium enema study, the column of barium is unable to pass beyond a certain point distal to the cecum so that the cecum itself cannot be properly delineated in its haustral markings by the barium; at the same time a large collection of gas appears at the site of the cecum, either in the mid-line or slightly to the right. The barium serves to show an obstruction of the large colon, above which distended gut, with or without fluid levels, will be seen.

The authors describe a procedure which they have found of value in the diagnosis of closed loop obstruction, both in the large and small gut. It consists essentially in a comparison of roentgen films made before and after attempts at decompression. These will show the gas bubble in essentially the same position and of the same configuration. If the films are superimposed, no decrease in its size will be found following the attempts at decompression. This points to a closed loop obstruction.

As soon as the diagnosis is made, immediate surgery is indicated, the type of operation depending upon the findings. If the intestines are viable, untwisting, cecostomy and cecopexy are the procedure of choice. If the intestines are gangrenous, a one- or two-stage procedure with resection is indicated.

Supralevator Abscess. Eugene A. Gaston and Lyman O. Warren. New England J. Med. **229:** 613–619, Oct. 14, 1943.

The authors' experience with a case of supralevator abscess has led them to describe the condition in an effort to make it better known and understood.

The supralevator space is that space in the pelvic cavity just above the levator ani muscles, anterior to the sacrum and posterior to the prostate in the male and to the vagina in the female. The route of infection of the supralevator space is not definitely established, but the most likely origin is from the crypts of Morgagni. Direct trauma has been known to cause this abscess. It may be due to extension upward from the ischiorectal space.

The clinical picture is often confusing. The onset is usually characterized by general malaise, with fever and leukocytosis. After a period of a few days or months, pelvic discomfort and a sense of rectal swelling occur. This discomfort may be relieved temporarily by defecation. Symptoms of low-intestinal obstruction develop. In men, urinary symptoms may occur. Finally localizing signs of abscess formation appear.

The diagnosis is usually established by digital and instrumental investigation. There are high localized tenderness and swelling in one quadrant or the entire circumference of the rectum. Proctoscopically there is definite narrowing of the rectum, with bulging of part of it. Extreme pain may be elicited by firm pressure on the skin between the tip of the coccyx and the anus. The abscess may rupture and spread in a variety of ways and directions.

A barium enema study may show the rectal narrowing and displacement. The condition is to be differentiated from cancer by the intact mucosa. Treatment is by incision and drainage. JOHN B. MCANENY, M.D.

THE SKELETAL SYSTEM

Ice Skater's Fracture: A Form of Fatigue Fracture. C. F. Ingersoll. Am. J. Roentgenol. **50:** 469–479, October 1943.

Fatigue fractures were first recognized in the metatarsal bones and were thought to be confined to these bones because of their peculiar anatomical arrangement. Recently, however, the same type of lesion has been found in other bones such as the femur, tibia, and fibula, where anatomical variations cannot be held responsible. The author reports 3 cases which he describes as "ice skater's fracture" occurring in the lower fibula. They were identical in the following respects: (1) All were in the same location in the lower fibula. (2) Each patient was nine years old. (3) All were boys. (4) The skates were tubular skates in which the attached shoe is elevated by metal tubes above the runner. (5) In each instance the skates were recently acquired.

The term "fatigue fracture" is suggested to denote all of those fractures occurring in apparently normal bone which seem to be due to the summation of microtraumata from repeated subfractural mechanical injury. Pseudofractures are not included in this category, as they are associated with a generalized metabolic disease. The roentgen findings in the author's cases were similar to those that have been described as occurring in march foot or march fracture of the metatarsal, except that the lesion was noted in the lower end of the fibular shaft. In one patient, examination of the other leg for comparison showed a similar lesion, which was without symptoms.

In attempting to explain the cause of these fractures, the author states that there is ample evidence that repeated minor traumata are responsible. The more inexperienced or tired the skater, the greater the eversion of the foot with which he skates. With the foot in eversion the weight-bearing line shifts laterally and runs approximately along the course of the interosseous membrane. This increases the pressure against the lateral malleolus.

Recognition of the nature of these fractures is extremely important, since they may be confused with primary malignant bone neoplasm, as has been done in the past in the case of fractures occurring in the tibia, fibula, and metatarsals. L. W. PAUL, M.D.

Double March Fracture. A Case Report. Samuel R. Terhune and Thomas S. Eddleman. Mil. Surgeon **93:** 310–311, September 1943.

A case of spontaneous fracture of the second and third metatarsals, occurring in a soldier with three months' army service, is reported. The fractures responded well to treatment and recent roentgenograms (after 6 months) show less excessive callus than at the first examination and slightly more thickening of the cortex at both of the fracture sites.

Treatment and Results in Localized Osteitis Fibrosa Cystica (Solitary Bone Cyst). A. D. McLachlin. J. Bone & Joint Surg. **25:** 777–790, October 1943.

According to the present concept of osteitis fibrosa cystica, there are three different forms. The generalized form affects the entire skeleton and is due to an adenoma of the parathyroid gland. The regional form shows involvement of one side of the body, one extremity, or a single bone in its entirety. The localized form is the solitary bone cyst.

A bone cyst begins on the metaphyseal side of the epiphyseal line, usually before the age of fifteen, and is most frequently found in the upper femur, humerus, or tibia. Pathological fracture is common and may be the sole factor in the discovery of the lesion. Roentgenographically the cyst is seen to be expansile and limited by the cortex. It may be crossed by trabeculae. It is usually filled with a greenish fluid and has a fibrous wall, in which many giant cells may be found.

This paper is based upon 27 cases of bone cyst. Fracture was the presenting symptom in 17 cases. Five were treated by open operation and 12 by immobilization. Four patients had repeated fractures and required operative interference and in 2 other cases the joint was opened to prevent fracture. Thus immobilization gave satisfactory results in only 6 of the 12 cases. Curettage was done in 11 cases and led to good final results in 10 patients. In one case a second curettage was done and bone slivers were placed in the cavity. Including this case, curettage and packing with bone slivers were done in 11 cases, all with favorable results. Irradiation was used in 2 cases, without noticeable improvement.

The conclusion reached is that in the presence of fracture, the treatment of choice is open operation, which may be done within a few days. Curettage, with packing of the cavity with bone slivers, is the most satisfactory procedure. JOHN B. MCANENY, M.D.

Recent Advances in the Treatment of Ruptured (Lumbar) Intervertebral Disks. Walter E. Dandy. Ann. Surg. **118:** 639–645, October 1943.

The author states that in 95 out of 100 cases with a history of low back pain with sciatica down the back of the leg, occurring in attacks and intensified by coughing and sneezing during the acute stage of pain, a diagnosis of ruptured intervertebral disk can be made on the symptoms alone. Spondylolisthesis may cause 2 per cent of the remaining cases, a congenitally defective fifth lumbar vertebra 2 per cent, and tumors of the cauda equina 1 per cent.

Only two examinations are important: (1) roentgenography, which will exclude other lesions and frequently in the lateral view will indicate a ruptured disk by the narrowing of an intervertebral space; (2) determination of the Achilles reflex, which is normal in over half the cases but may be absent or reduced, indicating involvement of the fifth lumbar.

One-third of all intervertebral disks protrude; the remaining two-thirds are concealed. According to the author, spinal injections of lipiodol, air, etc., are strongly contraindicated, as they fail to disclose the concealed disk and are not necessary for diagnosis. Spinal punctures should also be avoided. In the last 400 operations a disk has been missed only once; in this case a tumor was present. In none of these were contrast media used.

In 98 per cent of all ruptured lumbar disks the site is at the fourth or fifth vertebra, which the author believes is due to a shift in the plane of the articular process from the horizontal to a transverse direction. About 20 per cent of all patients with ruptured disks have two —one at the fourth and the other at the fifth lumbar.

Fusion operations are contraindicated. Thorough removal of the entire necrotic content of the interior of the disk with curettes is the best insurance against recurrence.

Brucella Spondylitis. Case Report. Martin Dobelle. Am. J. Surg. **60:** 130–133, April 1943.

The author reports a case of undulant fever in which serial roentgenograms showed a rapidly progressive destruction of the fourth lumbar vertebra with suspicious involvement of the third. A successful fusion operation was done and a course of brucellin therapy was given, with favorable results.

Arthritis of the Acromioclavicular Joint. Albert Oppenheimer. J. Bone & Joint Surg. **25:** 867–870, October 1943.

Of the many painful conditions about the shoulder joint, arthritis of the acromioclavicular joint has received but little attention in the literature. There is no clinical or physical sign characteristic of this particular form of joint involvement but roentgenograms will show characteristic changes.

Normally the joint is a clear space 1 to 3 mm. wide, with the articular surfaces clean-cut and straight, notched, convex, or concave. The articular capsule and ligaments cast a tubular or spindle-shaped shadow about the joint not rising more than 1 mm. above the joint edges.

Tubercu'ous arthritis is of rare occurrence. Rheumatoid arthritis is seen, but is also found in other joints. Osteoarthritis is much more common. The findings are enlargement of the capsule, narrowing of the joint space, and eburnation of the joint surfaces. Or there may be marginal overgrowth and roughening of the joint surfaces with widening of the space. The subchondral bone shows an irregular honeycomb appearance.

The author has had great success with roentgen therapy in these cases. He gives 50 r through a 5 × 5 cm. portal every five to seven days for two to eight treatments. The factors used are 140 kv., 20 ma., 0.5 mm. Cu and 1.0 mm. Al at 50 cm. distance.

JOHN B. MCANENY, M.D.

Air Arthrography in the Diagnosis of Internal Derangement of the Knee-Joint. E. W. Somerville. Proc. Roy. Soc. Med. **36:** 663–664, October 1943.

Thirty patients suspected of having some internal derangement of the knee joint were examined by air arthrography. In 9 the findings were negative. Roentgen evidence of meniscus injury was confirmed in 18 cases at operation. Air arthrography was unsuccessful in the remaining 3 cases because of effusion that obscured the cartilages.

The technic includes a twenty-four hour skin preparation. From 80 to 120 c.c. of air, filtered through cotton-wool, is injected into the joint space until a positive pressure is produced. A firm bandage is wrapped above the knee to empty the suprapatellar pouch. The knee is held in flexion over a curved cassette and the lateral or mesial joint space to be examined is further widened by adduction or abduction of the tibia. Three tangential views are then made of each cartilage to demonstrate the anterior, middle, and posterior portions. A true postero-anterior projection of the knee joint is also made with the knee in flexion.

Reaction consisting of moderate pain and effusion occurred in 8 patients and lasted for a few days.

Reproductions of roentgenograms accompany this brief report. LESTER M. J. FREEDMAN, M.D.

Hemangioma of the Synovial Membrane of the Knee Joint Cured by Synovectomy. Paul H. Harmon. Arch. Surg. **47:** 359–363, October 1943.

All published cases of hemangioma of the knee joint include the same striking symptoms and signs. Intermittent swelling is usually of many years' duration and is confined to the single joint. It is of insufficient moment to detract from the patient's general health. Examination in the acute phase shows that elevation or compression of the joint leads to disappearance of the swelling. Motion is limited by the swelling. Roentgenograms may reveal no abnormality except enlargement of the soft tissue shadow, or they may show subcortical absorption beneath the articular surfaces, a change similar to that seen in the recurrent hemorrhages of hemophilia. The monarticular distribution and absence of blood changes will rule out this latter condition. The final diagnosis is usually established by arthrotomy. The tendency to profuse hemorrhage can usually be controlled by packing or by constriction of the blood supply to the extremity.

The pathological changes may consist of a diffuse involvement limited to the synovial membrane, or the lesion may be of a cavernous form involving the surrounding muscles and fasciae. The tendency to spread is limited.

Treatment consists of synovectomy. Sclerosing agents are unsuccessful, but in 3 instances cure was effected by roentgen rays and radium (reported by Bennett and Cobey: Arch. Surg. **38:** 487, 1939). A case in a 9-year-old boy treated successfully by synovectomy is reported in this article. LEWIS G. JACOBS, M.D.

Synovioma Involving the Knee Joint: Case Report. Malcolm S. Eveleth and Philip S. Brezina. Yale J. Biol. & Med. **16:** 27–30, October 1943.

A "diffuse" synovial sarcoma is reported in a 61-year-old white female. The history was of four years' duration and shows the difficulty in making an early diagnosis. The symptoms were: steady boring pain, not relieved by heat or rest; progressive increase in the size of the joint; flexion deformity of the knee with loss of ability to flex and extend the joint. Inguinal metastases were present and a palliative amputation was done to relieve pain. The diagnosis was confirmed by gross and microscopic examinations, which are reported in detail. X-ray therapy to masses in the groin caused some decrease in size, although these tumors do not respond well to irradiation.

X-ray examination of the right knee joint revealed a poorly circumscribed, lobulated soft-tissue tumefaction appearing to infiltrate the muscles. There was extensive destruction of the cortex of the lower third of the shaft, metaphysis, and condyles, with periosteal new bone formation of parallel and perpendicular type. In the femoral condyles small areas of rarefaction alternated with zones of sclerosis. Narrowing of the joint space was demonstrable, with a break in the cortical outline of both condyles.

Lazarus and Marks (Surgery **13:** 290, 1943) state there are 76 recorded cases of synovioma, of which 48.7 per cent occurred in the knee joint. Synoviomas are

classified as: (1) encapsulated or circumscribed; (2) diffuse. Treatment consists in wide excision for easily accessible, small, encapsulated tumors and amputation for highly malignant growths, inaccessible encapsulated tumors, and local recurrences.

SIDNEY LARSON, M.D.

Osteochondritis Dissecans of the Astragalus. Milton C. Cobey. Mil. Surgeon **93:** 184–186, August 1943.

Three cases of osteochondritis dissecans of the dorsal surface of the astragalus are presented. Although osteochondritis dissecans of the ankle is rarely seen, the author urges a careful x-ray examination of every sprain of this joint, in order that appropriate treatment may be instituted promptly. In each of the cases reported here, a roentgenogram showed a defect in the dorsal articular surface of the astragalus. Surgical excision of the plaque was done in all three instances, with complete recovery; the period of disability was prolonged, however, in two of the patients because in one the condition was not recognized for seven months and in the other early adequate treatment was not carried out.

Congenital Talonavicular Synostosis. Case Report of a Rare Anomaly. D. H. O'Donoghue and L. Stanley Sell. J. Bone & Joint Surg. **25:** 925–927, October 1943.

Talonavicular synostosis is a rare congenital anomaly of the foot and may be accompanied by other abnormalities of bone formation. The authors present the seventh recorded case. The unusual features in this instance are two rather large cuneiform bones in place of the usual three and the bilaterality of the anomalies.

JOHN B. MCANENY, M.D.

GYNECOLOGY AND OBSTETRICS

Study of the Uterine Canal by Direct Observation and Uterogram. W. B. Norment. Am. J. Surg. **60:** 56–62, April 1943.

Two methods are described for detecting submucosal myomas protruding into the uterine canal and uterine polyps producing bleeding. The first is by direct observation through a foroblique telescope following insertion into the uterus of a rubber tissue bag which is inflated with air or water. By this means a greater part of the uterine canal may be visualized and the endometrium observed in its natural color.

The second method of study is by the uterogram. After dilatation of the cervix and curettement in the usual manner, a small rubber tissue bag (half the length of the depth of the uterine canal), attached to the end of a two-way mushroom catheter, is inserted into the uterus. If the bag is moist, this can be accomplished with ease by a uterine probe. To determine the position of the bag, a small amount of air, usually 6 to 10 c.c., is instilled into it before the patient leaves the operating room. If there is difficulty in instilling the air, the bag is withdrawn and re-inserted. The following day the patient is taken to the x-ray room, the bag is again instilled with air, and anteroposterior, postero-anterior, and lateral roentgenograms are made, covering the entire circumference of the bag. Defects in the contour of the bag thus observed suggest the possible presence of a submucosal myoma or polyp. The defect, if found, is usually fairly definite and with a wide base. Small defects on one contour of the balloon may be due to an excess amount or wrinkling of the bag in the uterine canal. In the event of their occurrence, the air in the bag should be released and further x-ray studies made to determine if the defect persists. If there is much gas in the intestinal tract, as shown on a flat plate made previous to the insertion of air, it may be difficult to distinguish the outline of the air from the gas in the intestine. In this event an opaque medium may be substituted for the air, a 12.5 per cent sodium iodide or diodrast solution probably being the best. If a definite defect is found on one contour of the bag with this solution, a weaker solution, 3 to 4 per cent of sodium iodide, is injected. If there is a displacement of the weaker dye, it is believed that there is probably a growth protruding into the uterine canal.

Originally a No. 18 catheter was used in place of the mushroom catheter but, in spite of the fact that the vagina was firmly packed with gauze, the bag was frequently expelled into the vaginal vault in the reaction from the anesthetic. With the present technic the bag is attached to the mushroom catheter by a fine silk thread and is inserted with the aid of a uterine probe in the eyelet of the catheter, similar to insertion in the bladder. As the mushroom tip is beyond the internal os, expulsion of the bag is prevented. The dye is instilled in one opening of the two-way catheter and allowed to return through the other until no air is expelled. Following this, one end is clamped and the dye is injected.

This method of uterography has a number of advantages over ordinary salpingography. The folds of the uterine canal are pressed out, the bag can be inserted, the tube clamped, and different angle x-ray studies of the uterine canal can be made which would be impossible with the usual method. There is no leakage of the dye out of the cervical canal or the fallopian tubes. There is constant pressure in the uterine canal when the bag is used so that in x-ray studies from different angles the contour is of the same size and comparison is facilitated. There have been no ill effects following this procedure.

The author believes that by the use of the two methods described, the submucosal myoma or polyp may be detected more easily than by the curet. They will also aid in determining whether a palpable fibroid on the serosal surface is the cause of uterine bleeding or is merely coincidental.

Uterography. An Aid in the Diagnosis of Gynecological Pelvic Disorders. Ben H. Brunkow. Am. J. Surg. **61:** 394–399, September 1943.

The author describes his technic for uterography and discusses its advantages in the diagnosis of gynecological disorders, based on a review of 100 unselected cases.

A careful history of the patient should be taken and a physical examination should be made before uterography is begun. With the patient in lithotomy position, the cervix is exposed and grasped with tenacula and the cervical canal is explored with a small sound. The tip of a uterine cannula is inserted into the cervix, pushed firmly up to the rubber stopper, and held in place with tenacula. About 2 c.c. of heavy brominal are injected at a time and a roentgenogram is taken immediately. The usual number of x-ray exposures is three or four, *i.e.*, three anteroposterior and one lateral. Delayed emptying of the material from the uterus or the fallopian tubes may be checked at twelve to twenty-four hours after the injection. Normally

emptying occurs in twelve hours. The brominal used in the cases studied was well absorbed in twenty-four hours.

Uterography is particularly useful in the diagnosis of endocervicitis, intra-uterine tumors, carcinoma, and the chronic forms of adnexal disease in which the pathological process is not readily palpable. It is strongly contraindicated during pregnancy.

Fallopian Tube Visualization. Jason H. Robberson. Texas State J. Med. **39:** 340–346, October 1943.

Uterosalpingography is a simple and safe procedure providing the following contraindications are observed: pelvic inflammatory disease; advanced cardiac lesions; recent uterine bleeding, which may be secondary to neoplasm; the immediate premenstrual, menstrual and postmenstrual periods; pregnancy; any severe constitutional ailment. This method of examination is a distinct aid in the determination of abnormalities of the cervical canal, uterine cavity, and fallopian tubes. Particular emphasis is placed on its value in demonstrating tubal patency. The question of sterility is discussed in some detail.

Although the author admits that lipiodol produces a clearer and more detailed roentgen picture, he prefers the use of skiodan-acacia because of its rapid excretion. The usual amount of the solution required is 5 to 8 c.c. A second or third roentgenogram is made several minutes following the initial exposure. Because of the rapid absorption of the skiodan mixture, a 24-hour roentgenogram is useless. The author describes his technic.

Reproductions of roentgenograms, made with both lipiodol and the skiodan mixture, are furnished, showing a normal internal genital system, a bicornate uterus, a chronic hydrosalpinx, surgically sealed fallopian tubes, and a uterine fibroid.

LESTER M. J. FREEDMAN, M.D.

Parasitic Ovarian Cysts. Herman I. Kantor. Am. J. Obst. & Gynec. **46:** 412–417, September 1943.

The development of parasitic tumors may be divided arbitrarily into four stages, depending on the degree of diminution of the primary blood supply: (1) reduction in the original vascular supply, due usually to a slow torsion of the mass on its pedicle; (2) formation of adhesions between the mass and adjacent tissues or the omentum; (3) additional torsion and a further decrease in the primary blood supply followed by secondary vascularization through the adhesions; (4) further torsion to the point of complete amputation of the pedicle. With the fourth stage the tumor takes on a completely parasitic existence and the pedicle tends to become atrophied and fibrotic.

Among the ovarian parasitic tumors, the type most frequently seen is the dermoid. This is as would be expected, since the ovarian dermoid often is subject to torsion. Serous cysts, solid ovarian tumors, and relatively normal adnexa have been reported.

These parasitic cysts are most often associated with the omentum, in which they tend to become embedded. They have been found, however, attached to the uterus, the broad ligament, the bowel, and the bladder. The parietal peritoneum is occasionally involved.

An accurate preoperative diagnosis of parasitic cyst of the ovary has not been made. Pain has been the predominant symptom in almost all of the recorded cases.

In the case presented here the x-ray films revealed several clusters of calcification within the pelvis. One had the typical appearance of a calcified fibroid and another was thought possibly to be an additional fibroid. No abnormality in either the urinary tract or bladder was found by intravenous pyelography, but the calcified masses caused extrinsic pressure on the bladder.

On exploratory laparotomy, the right ovary was found to be converted into a multilocular dermoid cyst containing three separate portions. It was attached laterally by the right infundibulopelvic ligament, about which the amputated right tube was twisted. It was attached also to the peritoneum over the dome of the bladder by a pedicle. Both of these pedicles were twisted. A single smaller dermoid cyst, probably part of the right ovary, was found embedded extraperitoneally in the right lateral pelvic wall. In addition, another cyst posterior to the uterus was found, which was attached completely to the omentum by a pedicle. This was twisted 2 1/2 times on itself, but a new band from the omentum to the lateral aspect of this cyst was not twisted. The patient made an uneventful recovery after removal of the cysts.

The torsion of the omental cyst in this case represented a beginning decrease of the secondary vascular supply. The new band of tissue suggested the beginning of the tertiary stage, while the calcified and necrotic dermoid found in the lateral pelvic wall probably indicated the end stage of development, a quiescent, completely parasitic, degenerated tumor. The finding of ovarian tissue in the omental cyst may explain the etiology of some dermoid cysts thought to be primary in the omentum.

STEPHEN N. TAGER, M.D.

THE GENITO-URINARY TRACT

Estimation of Renal Function Based on Specific Gravity Changes Following Intravenous Urography. George O. Baumrucker. J. Urol. **50:** 290–300, September 1943.

Baumrucker states that the excretion of diodrast and the related iodide preparations used in intravenous urography closely parallels phthalein excretion, and that these substances are of value for kidney function tests. The advantage of these compounds is that they can be used on patients with bloody urine. It has also been found that there is a close correlation between the excellence of the pyelogram and the increase in the specific gravity of the urine following diodrast injection. Good contrast urograms are secured in those patients in whom the specific gravity of the urine rises to at least 1.040 during the test. This rise in specific gravity is due undoubtedly to a concentration of the excreted urine by the excreted diodrast. Taken together with the volume of the urine excreted in any given time, it furnishes a basis for calculating the amount of contrast material excreted. The following formula is used:

$$\text{Volume of dye} = \frac{(\text{vol. of mix.}) \times (\text{increase in specific gravity})}{(\text{sp. gr. of dye}) - (\text{sp. gr. of urine})}$$

in which the *volume of dye* is the amount of dye excreted, *vol. of mix.* is the amount of urine excreted with dye in an arbitrary time period (which the author advises should be 15 minutes to fit with the 15-minute phthalein test), and *increase in specific gravity* is the specific gravity of the urine during the test minus the specific gravity of the urine immediately before the test.

The author recommends that films be made in the Trendelenburg position at five and fifteen minutes after injection of the dye, and another in the erect position immediately thereafter. He finds that there is thus better filling of the pelvis and ureters. The patient is catheterized before injection of the dye and immediately after the fifteen-minute film, if there is any residual urine. Otherwise he voids at these times. The specific gravity of the two specimens and the volume of the second are determined. The specific gravity of 35 per cent diodrast is 1.193; of 50 per cent neoiopax 1.335; of 75 per cent neoiopax 1.495.

JOHN O. LAFFERTY, M.D.

Management of Hydronephrosis Due to Ureteropelvic Obstruction: Preliminary Report. Roy B. Henline and Joseph H. Menning. J. Urol. **50:** 1–24, July 1943.

Because of the high incidence of nephrectomy and the poor results obtained by plastic repair for hydronephrosis due to ureteropelvic obstruction, the authors discuss three principles in the successful management of these cases.

(1) The true etiology of the condition must be discovered. In the majority of the cases, this is a stenosis at the ureteropelvic junction. The much blamed aberrant renal vessel is usually not the cause or is only a secondary finding at operation.

(2) The surgical procedure must restore a well draining pelvio-ureteral outlet.

(3) Satisfactory plastic repair requires prolonged nephrostomy drainage and splinting of the area of repair.

In this preliminary report 18 operations on 14 patients are presented, the longest follow-up period being seven months. Final results must necessarily wait for years.

Often the only symptoms of this condition are vague gastro-intestinal complaints. Pain is the outstanding feature, and its severity is proportional to the speed with which the hydronephrosis develops. The urine is negative until infection is superimposed. Urinary findings and symptoms will then be obtained. Diagnosis is based on the retrograde pyelogram. While dilatation of the pelvis is considered a helpful finding, delay in emptying time of the pelvis is stressed. Little importance is placed on reduced function of the affected kidney, as the function often improves after prolonged drainage.

The causes for obstruction are: congenital or acquired stenosis at the ureteropelvic junction, hypertrophy of the ring muscle at the ureteropelvic junction, high insertion of the ureter in the pelvis, fibrous bands with kinks of the ureter, accessory renal vessels, congenital ureteral valves, and combinations of the above. In 15 of the 18 kidneys examined ureteropelvic stenosis was found, while only one case was considered to be due solely to an accessory renal vessel. In some of the cases the caliber of the ureter could not be gauged from its external appearance. In such cases, the pelvis of the kidney should be distended with saline injected through a fine needle, and the emptying time observed. With delayed emptying, the ureter, when opened, will often show stenosis not suspected before incision.

For repair a modification of the Y-plasty procedure described by Schwyzer is used. Through a nephrostomy a 24 F mushroom catheter is placed in the renal pelvis and a 10–12 F soft rubber catheter is run down the ureter past the site of the plastic repair. In general, these catheters are left in place until the roentgenograms, taken with dye run into the renal pelvis through the mushroom catheter, show no leakage from the site of the anastomosis. This is usually four to six weeks.

Primary emphasis is placed on this prolonged drainage and splinting of the operated ureter until plastic repair is complete, to prevent secondary scarring and contraction.

Reports and roentgenograms of the 18 cases, with illustrations of the operative technic, are presented.

J. FRANCIS MAHONEY, M.D.

Renal Ectopia: Report of Two Cases with a New Method of X-Raying Pelvic Ectopia. Nicholas S. Scarcello. J. Urol. **50:** 25–28, July 1943.

The author reports a case of bilateral renal ectopia, the 23d such case recorded in the literature. The advisability of a complete urological study in cases presenting lower abdominal masses is pointed out, so that exploratory operation may be avoided, since in this condition operative treatment is not necessary.

In the case reported, the intravenous urogram was unsatisfactory, but a retrograde pyelogram disclosed a bilateral ectopia.

A case of unilateral ectopia is also described in connection with which it is suggested that films be made with the patient in the prone position and the tube angled 45 degrees. In this way, the shadow of the dye-filled pelvis is projected away from the sacrum so that visualization is improved. ELLIS C. OSGOOD, M.D.

Report of a Case of Wilms' Tumor in an Adult. Martin J. Loeb. J. Urol. **50:** 268–273, September 1943.

The origin of renal tumors, particularly of the embryonal type, is still under discussion, with most observers no longer subscribing to the original conception advanced by Wilms that the tumor bearing his name arises from the inclusion of various embryonal tissues. With frequent reference to the literature, the author summarizes the evidence in support of the premise that these tumors are derived from the renal blastema. This is mesenchymatous embryonal tissue, which may differentiate into all the elements composing the kidney, *viz.*, epithelial, glandular, vascular, and connective tissue, thus allowing for considerable variation in the histopathologic structure of the tumors. The author states, however, that these are usually adenomyosarcomata and all may be classified as embryomata.

Typical adenomyosarcomata, as originally described by Wilms, occur rarely in the adult, the present case bringing the total number reported up to 30. After reviewing the work of L. W. Smith on renal neoplasms, however, the author expresses the opinion that true sarcomata represent variants of Wilms' tumors and as such should be included. Were this done, the number of cases in adults would be greatly increased.

The case recorded here is that of a 49-year-old housewife who had symptoms referable to the right flank for approximately one year prior to admission, with acute pain, urgency, frequency, and hematuria of one week's duration. Cystoscopy showed bloody urine in the bladder. On ureteral catheterization bloody urine was obtained from the right kidney with no return of indigo carmine from that side. Bilateral pyelograms revealed nothing abnormal on the left but showed on the right

side a gross enlargement of the kidney in the region of the upper pole, with elongation and distortion of the superior calices. A communicating area was also filled with the dye, leading to a roentgen diagnosis of cyst of the upper pole of the right kidney. The preoperative clinical diagnosis was carcinoma of the kidney.

A right nephrectomy was performed and a postoperative diagnosis of Wilms' tumor was made. Photographs of the gross specimen and photomicrographs of the pathologic sections are included.

A course of postoperative roentgen therapy was given and the patient was well twenty months later.

AGRIPPA G. ROBERT, M.D.

Primary Carcinoma of the Ureter. Samuel A. Jaffe and Anthony J. Mendillo. Am. J. Surg. **62:** 126–133, October 1943.

Primary carcinoma of the ureter is a comparatively rare disease, though, with improvements in urologic technic, it is now being recognized more frequently. Two-thirds of all the reported cases have been published in the past ten years.

Ureteral neoplasms may be papillary or non-papillary. The tumor may involve one or several parts of the ureter, may be small or extensive, and may or may not encircle the lumen. Spread tends to occur to surrounding tissues, to regional lymph nodes, and by the blood stream to other parts of the body, particularly the liver and lungs. In about 75 per cent of the reported cases, the primary growth occurred in the lower third of the ureter. In many cases it has been seen cystoscopically, protruding into the bladder through the ureteral orifice.

Hematuria is the most frequent and earliest symptom, appearing in about 75 per cent of the reported cases. Pain is next in frequency. It may be one or any combination of the following types: (1) ureteral colicky pain, due to ureteral obstruction or the passing of blood clots down the ureter; (2) dull aching pain in the kidney region and in the flank, due to ureteral or pelvic distention; (3) referred pain, due to involvement of the neighboring tissues. The neoplasm itself is seldom palpable, but the enlarged hydronephrotic kidney secondary to the ureteral obstruction may be felt as a mass in the loin.

Urinalysis, cystoscopy, and urography are of utmost importance in the diagnosis of ureteral cancer. Red blood cells are undoubtedly present in the urine at some time; pus is generally found; cancer cells or even fragments of the tumor may occasionally be seen. Cystoscopic examination may show blood spurting from the affected ureter; if obstruction from the growth is complete, no urine appears from the ureteral orifice.

A film of the abdomen often shows an enlarged kidney shadow due to the associated hydronephrosis. Excretory urograms are of limited value in demonstrating either a filling defect or the stricture in the ureter. Retrograde pyelo-ureterography is the procedure of choice to reveal the actual lesion and its position. A catheter must be passed, or at least its tip engaged in the ureteral orifice, so that the ureter may be filled sufficiently to show the defect. It is important to note whether the filling defect is constant. For this purpose, serial pyelograms are advised. The filling defect may take several forms: (1) a ring-like obstruction; (2) an ovoid defect, large or small; (3) a moth-eaten appearance, due to extensive involvement by a papillary type of neoplasm; (4) multiple defects, due to many implantations.

A bleeding ureteral neoplasm may be so small that it will not cause obstruction, will not show a filling defect, will not produce hydronephrosis, and will not appear as a palpable mass upon surgical exposure. If a nephrectomy has been performed and the kidney does not explain the source of bleeding, or if there is persistent hematuria after the nephrectomy, prompt ureterectomy should be carried out. It is also of utmost importance that in all cases of hydronephrosis, especially in patients over fifty years of age, the causative factor be definitely ascertained.

In the treatment of tumors of the ureter, the best surgical procedure at present is a total nephro-ureterectomy with removal of a cuff of the bladder and of the perirenal and peri-ureteral fat. Preoperative and postoperative irradiation are worth while. Postoperative irradiation helps to prevent local and bladder recurrences and to relieve the pain of extension and metastases. In the past, the prognosis in ureteral cancer has been poor. It is now vastly improved because of earlier diagnosis, earlier and more adequate surgery, and proper irradiation.

Two cases of primary carcinoma of the ureter are presented, bringing the total number of reported cases to 175.

Solution of Vesical Phosphatic Calculi. Daniel J. Abramson. J. Urol. **50:** 197–201, August 1943.

Urinary lithiasis long has been one of the major problems of urologists. Solution of calculi by medical means has been desired. Crowell and also Albright, Sulkowitch, and Chute demonstrated the solution of cystine stones by alkalinization of the urine. Higgins had some success with large doses of vitamin A and an acid or alkaline ash diet. Suby and Albright have reported six cases of phosphatic calculi dissolved with their solution "G" (citric acid, magnesium oxide, sodium carbonate).

The author reports a case in which a large phosphatic bladder calculus was dissolved by solution "G" when surgical intervention might have proved fatal. His patient was a 64-year-old white male on whom cystotomy and two transurethral resections had been performed in 1941. In April 1942, a large bladder calculus, 3 × 2 cm., was discovered. Since the patient was a poor surgical risk, treatment consisted of attempts to acidify the urine. This was unsuccessful. By December 1942 the calculus had increased in size. Bladder irrigations with citric acid solution (solution "G") were carried out intermittently from Dec. 5, 1942, to Jan. 1, 1943. By January 6 the stone had disappeared and voiding could be performed satisfactorily.

There was no chemical analysis of the calculus, but the author states that it was undoubtedly a phosphatic one, since it occurred in an alkaline urine caused by *B. coli*, in which phosphatic crystals were found. It was due to stasis resulting from prostatic hypertrophy and infection by *B. coli*, a urea-splitting organism.

The advantages of the irrigation method of treatment with solution "G" are as follows. It is associated with very little discomfort; is suitable for the aged; removes dangers of operative manipulations and complications; avoids irritation of the bladder mucosa, thought to be due to the action of the magnesium ion. It is thought that it not only dissolves the calculus but also loosens organic matrix.

STUART P. BARDEN, M.D.

Adenoma of the Kidney with Associated Lesions: Report of Three Cases. Henry Bugbee. J. Urol. 50: 389–398, October 1943.

Renal adenomas are usually small, single or multiple benign tumors of gray or yellow color. They are located in most instances beneath the renal capsule and are clinically silent, except in the rare event that one reaches such dimensions as to offer the serious problem of differentiation from malignant tumor.

Three histological patterns are recognized. In one, the cells are arranged in groups without distinct lumina. In another type the ducts may be dilated and show hyperplasia or actual papillary formations. The third variety resembles adrenal rest tissue and is made up of cuboidal or cylindrical cells which may or may not contain fat. There is no sharp dividing line between adenoma and normal epithelium on the one hand and carcinoma on the other.

Three case histories are reviewed. In the first case, that of a 43-year-old man, a hydronephrotic, sclerotic kidney was removed. It contained a small subcapsular adenoma characterized by cuboidal cells forming acini. In the second patient, a woman aged 57 years, the excised kidney was a pyonephrotic sac containing two calculi. An adenoma measuring 3.5 × 2.5 cm. was present in the upper pole, showing histologically closely packed tubules lined by cuboidal fat-containing cells. The third patient, a 54-year-old man, was operated upon for renal tuberculosis. The kidney revealed, in addition to the tuberculous abscess in the lower pole, a large adenoma in the upper pole, measuring 5 cm. in diameter. This was well encapsulated and made up of cuboidal and columnar cells in papillary arrangement. The remaining parenchyma was markedly sclerotic.

The author believes that these cases lend support to the theory that adenomas arise most frequently in kidneys altered by vascular sclerosis and are the result of reactive proliferation of tubules. He emphasizes the fact that large adenomas can rarely, if ever, be differentiated from carcinoma prior to surgery.

JOSEPH SELMAN, M.D.

VENOGRAPHY

Venography. I. Its Use in the Differential Diagnosis of the Peripheral Venous Circulation. II. A Simplified Technic. Jerome Mark. Ann. Surg. **118:** 469–477, September 1943.

J. C. dos Santos' method for the roentgenologic study of the veins of the lower leg is described. The heel is elevated on a 6-cm. block and rests on its mesial surface. Under local anesthesia a 2-cm. incision is made 1 cm. behind the external malleolus. The lesser saphenous is isolated, the distal portion tied, and a small cannula inserted into the proximal portion. Twenty cubic centimeters of a 35 per cent diodrast solution are injected at a uniform rate, taking about 60 seconds. The roentgenogram is taken during the injection of the last few cubic centimeters. It is possible to picture the deep venous circulation of the calf and a good portion of the femoral vein on a 14 × 17 in. film.

The author has found it possible, in most cases, to modify this technic by direct venopuncture. With a tourniquet around the ankle, a No. 21–22 gauge needle is inserted into the most prominent vein on the anterolateral surface of the ankle. The tourniquet is then released, and the remainder of the procedure is completed as described. Better visualization of the deep venous tree is secured by an exaggerated Trendelenburg position. The application of a tourniquet below the groin prevents loss of the dye before the picture is taken and causes more complete filling of the deep system.

Venography has been employed in many obscure cases of chronic leg swelling and leg pain in which the status of the venous and lymphatic circulation could not be readily determined by the usual chemical tests. A number of cases are presented. Of special interest is a case of Buerger's disease in which marked changes in the deep venous tree were demonstrable.

FOREIGN BODIES

Foreign Body Localization and Extraction. Description of a Method More Accurate Than That Used by the Army. Lewis Gregory Cole. Am. J. Surg. **60:** 3–12, April 1943.

A two-point method for the localization of foreign bodies is described. One mark is made on the upper surface and the other on the under surface of the part to be examined, each in line with the foreign body as observed fluoroscopically with the tube beneath the table. The mark on the upper surface is recorded in exactly the same manner as in the one-point method now in use in the U. S. Army. To determine the location of the second mark a ring pointer may be placed beneath the part and moved into such a position that the shadow cast by it on the fluoroscopic screen perfectly encircles the image of the foreign body. A line drawn through the two points transects the foreign body. An x-ray caliper has been designed and constructed to facilitate making both of these marks at one time. The accuracy with which the roentgenologist does this is recorded on a small roentgenogram made either on film or on paper.

A companion surgical caliper is so constructed that the part can be repositioned by the surgeon exactly as it was at the time the localization was done by the roentgenologist. To do this the distal end of the lower arm of the surgical caliper is fixed on the under mark and the part so positioned that the distal end of the upper arm rests exactly on the upper mark. The foreign body must therefore lie in a direct line between the end of the upper arm and the end of the lower arm of the caliper. In the upper arm of this caliper there is a knitting-needle-like pointer that acts as a guide to direct the surgeon toward the foreign body. There is also a stop on the pointer which indicates the exact depth of the foreign body beneath the surface.

In the author's opinion the two-point method is much more accurate than the one-point method adopted by the Army, with the additional advantages of adaptability to any available apparatus, greater convenience, and low cost. Both fluoroscopic and roentgenologic examinations can be made. Furthermore, the x-ray unit and localizing equipment can be taken to the patient, which is impossible with the one-point method.

An Adaptor for Fluoroscopic Depth Localization. Leo Mackta. Mil. Surgeon **93:** 372–375, October 1943.

A fluoroscopic depth localizer for foreign bodies, adaptable to most commercial fluoroscopes without any alteration of the machine, is described. This localizer depends upon the measured movement of a lead wire in a cassette-like box of thin plywood, 12 × 16 × 3/4 in. The patient is placed against the box, on the fluoroscopic table, and the depth determined is meas-

ured from the part of the patient in contact with the box. The shadow of the foreign body is made to move from one end of the screen to the other by moving the tube screen set in its guides. The lead wire is shifted by a sliding arm projecting from the box. Along this arm is a second (dummy) slide which is used for the initial or zero setting. The method of operating the localizer and the details of construction are given.

TECHNIC

Optimum Kilovoltage Technique in Military Roentgenography. Arthur W. Fuchs. Am. J. Roentgenol. **50:** 358–365, September 1943.

For a given thickness of a particular body part, the wave length of the roentgen rays employed to penetrate the tissues must be adequate or, in other words, optimum. The milliamperage and time control the number of roentgen rays or intensity of radiation, and proper adjustment of these factors will produce adequate exposure of the roentgen film. When the roentgen-ray wave length is optimum, a lesser amount of milliampere-seconds is usually needed for the exposure than that habitually employed for the same purpose with lower kilovoltages. When optimum kilovoltages are used, the exposure latitude is sufficiently great to permit either halving or doubling the milliampere-second value to obtain the desired density for each thickness classification of patient.

A consolidated technic chart, including standard roentgenographic projections, is furnished in the text. In using the chart any density differences should always be compensated for by milliampere-seconds and not by kilovoltages, because the latter have been proved qualitatively optimum for the projections listed.

The author has found that this technic greatly facilitates the training of Army roentgen-ray technicians, and it was for this purpose that the exposure system described was developed.

CLARENCE E. WEAVER, M.D.

RADIOTHERAPY

NEOPLASMS

Pulmonary Metastasis and Pneumonitis Following Radiation Therapy for Cancer of the Breast. Eugene P. Pendergrass and George White. Am. J. Roentgenol. **50:** 491–498, October 1943.

A study of 54 cases of cancer of the breast with pulmonary metastases is reported. The authors were interested in determining whether irradiation prior to the metastasis will influence the type of shadow that the subsequent metastatic lesions will produce and also to determine whether infiltrative metastases of the lung from cancer of the breast can be differentiated from radiation pneumonitis.

The metastatic lesions were classified according to their essential types as nodular, infiltrative, and pleural (with or without effusion). The analysis of this series of cases seems to indicate that increasing amounts of premetastatic irradiation to the lung fields tend to be followed by the infiltrative type of metastases, when these do develop, while the nodular type usually occurs where little or no radiation has been directed to the lung field. The pleural type of metastasis occurred equally after all degrees of irradiation. The diagnosis of nodular and pleural metastases is not difficult, but the infiltrative type may be confused with pneumonitis following irradiation.

In addition to the changes described by others as occurring in radiation pneumonitis, the authors observed bleb formation on the affected side in 3 cases. The blebs appeared to be secondary to the extensive lung changes in patients who had lived for years following treatment. In one patient a pneumothorax developed after a possible rupture of one of the blebs, and no unusual changes in either the parietal or visceral pleura could be seen. There were no pleural adhesions and the lung collapsed readily from the thoracic wall. The term "radiation pneumonitis" seems to be a more accurate description for the condition than pleuropneumonitis, since involvement of the pleura may not be present.

The authors were unable to find a group of diagnostic criteria which would enable one to differentiate between infiltrative metastases and pneumonitis. All the changes that occur following irradiation may also appear as a result of infiltrative metastasis, with the possible exception of bleb formation. L. W. PAUL, M.D.

Frequency, Clinical Course and Treatment of Metastases from Cancer of the Breast. Jacob R. Freid and Henry Goldberg. Am. J. Roentgenol. **50:** 499–511, October 1943.

The data presented in this report are based on patients with cancer of the breast who died while on the radiotherapeutic and surgical services of the Montefiore Hospital for Chronic Disease, New York City. The material is divided according to the anatomical sites of involvement as follows: skin; regional lymph nodes; skeleton; lungs, pleura, and mediastinal lymph nodes; abdominal viscera; central nervous system.

The treatment of diffuse skin lesions is difficult and frequently fruitless. Isolated nodules or groups of nodules in small areas may be treated either by irradiation or surgery, but radiotherapy is preferable because it is less likely to be followed by further recurrences.

Metastatic involvement of the nodes in the axilla is difficult to control by irradiation, and palliation is about all that can be hoped for. Supraclavicular node metastases are usually a late manifestation, not amenable to irradiation. When supraclavicular nodes are seen earlier in the disease, with no evidence of extension elsewhere, intensive radiation therapy is indicated over a field considerably larger than the area of involvement.

In a review of 81 cases with skeletal metastases, it was found that in most of them the lesions were multiple, and in the majority there were associated metastases in other body systems. Pathological fractures of one or more of the long or flat bones were encountered in 26 per cent. Such fractures may heal if treated by radiation. The mode of treatment is determined by the extent of the lesions and the stage of the disease. When the foci are numerous, treatment is limited to the sites causing symptoms or to areas where fracture seems imminent. When the foci are slowly growing, and new involvements are few or absent, intensive therapy is indicated in order to achieve a more lasting control.

Concerning the involvement of the lungs, pleura, and mediastinal nodes, postmortem studies indicate that this is almost a constant feature. When the metastatic lesions are multiple, they are likely to be resistant to roentgen therapy and little is accomplished by treatment. The single conglomerate infiltration may be kept under control by intensive treatment for periods of time. Pleural effusion may disappear or be greatly improved.

Metastases in the viscera and in the central nervous system were found more frequently than previous reports would indicate. The response of intra-abdominal metastases to irradiation is poor. The same is true of central nervous lesions.

To those interested in this subject, it is recommended that the article be read in the original, since it contains much statistical material which cannot be satisfactorily abstracted.

L. W. PAUL, M.D.

Superficial Noninvasive Intraepithelial Tumors of the Cervix. Richard van Dyck Knight. Am. J. Obst. & Gynec. **46:** 333–349, September 1943.

From January 1927 through April 1943, 406 primary squamous-cell epitheliomata were observed on the gynecologic service of the Sloane Hospital for Women (New York), of which 17 were early, superficial lesions. In 10 of these cases the diagnosis was made from the examination of curettings from grossly normal appearing cervices in women with fibromyomata or chronic inflammatory disease of the adnexa. In only 2 cases were minute gross lesions of the cervix noted clinically and both were interpreted as papillary erosions. In 2 instances the disease had its origin in cervical polyps. The 17 case histories are given briefly.

The average age of the patients in this series was 44.1 years. Symptoms covered a span of three months to two and one-half years, the average duration being 14.2 months. Eleven patients had irregular intermenstrual bleeding. In the remaining 6 the complaints included profuse menstrual bleeding, abdominal mass, and dysmenorrhea. The presence of a carcinoma was completely unsuspected in 11 cases. In addition to epithelioma, 2 patients had polyps and 9 had fibroids, either of which is capable of producing abnormal vaginal bleeding.

All patients received radium in doses varying from 2,400 to 7,000 mg. hr., followed by deep x-ray therapy. One died in three years, of massive extension throughout the pelvis, and one after nine years, of intestinal obstruction. The other patients were alive at the time of the report. Although many of the cases are rather recent, it appears from the follow-up of the earlier cases that these superficial epitheliomas develop slowly and are relatively benign, as compared with the more obvious larger lesions involving the portio vaginalis. The site of all of these lesions was just at or within the internal os. The presence of squamous epithelium in cervical tissue is not uncommon in chronic cervicitis and polyps of long standing.

Some of the theories which have been advanced to explain the presence of squamous epithelium in cervical glands are discussed. Many authors have considered squamous metaplasia as a stage in the process of healing of cervical erosions. Only a small percentage of cervical erosions, however, reveal metaplasia. Another possibility is the direct transformation of columnar epithelium to squamous epithelium. This process has been noted in advanced chronic inflammatory processes elsewhere in the body.

Among 459 polyps from the Sloane gynecological service, 53 showed evidence of metaplasia, but of these, only 2 were malignant. Since 1927, the diagnosis of squamous metaplasia of cervical tissue has been made 232 times. In none of these lesions, except for the cases here reported, was there any evidence of carcinoma. Thirteen of these 17 were in areas of squamous metaplasia.

In none of the cases reported in this paper was any deep invasion found. Only one of the patients, as mentioned above, died of extension of the disease.

As far as prevention and therapy are concerned, there is no doubt that when removal of a uterus is indicated, complete hysterectomy, either by the vaginal route or from above, is the operation of choice, especially in the presence of a diseased cervix. When the diagnosis is made from biopsies, polyps, curettings or trachelorrhaphy tissue, the conventional use of radium and deep x-ray therapy would seem to be the method of choice.

Superficial non-invasive epitheliomata of the type described show occasionally a superficial resemblance to Bowen's disease. Both lesions present a disorderly cellular pattern, but this group of cases does not show the characteristic nuclear clumping and numerous *corps rondes* found in Bowen's disease. These lesions, over a period of time, show invasiveness, as evidenced by violation of the basement membrane. In Bowen's disease this has not been described.

STEPHEN N. TAGER, M.D.

X-Ray Treatment of Bone Tumors. Charles L. Martin. Texas State J. Med. **39:** 285–288, September 1943.

Prolonged palliation and a limited number of cures may be expected from roentgen therapy in carefully selected cases of bone tumor.

Most of the *benign tumors* are radioresistant, but giant-cell tumors, xanthomas, hemangiomas, and eosinophilic granulomas often respond fairly well to irradiation. X-ray therapy is particularly useful where these lesions are deep-seated, as in the spine, pelvis, and upper ends of the femur, where resection is often difficult and may interfere with good function.

In *metastatic bone lesions* relief of pain may frequently be obtained by roentgen therapy. Metastases from malignant melanoma and prostatic carcinoma are usually radioresistant. Those from cancer of the breast, on the other hand, are particularly radiosensitive. Direct irradiation of bone metastases from mammary carcinoma combined with x-ray castration will produce palliative results in a high percentage of cases.

Although no cures of bone- or cartilage-forming *sarcoma* by use of irradiation are recorded, most authorities believe this method useful to relieve pain and as a preoperative procedure. In a recent report concerning a study of 400 cases in the Bone Tumor Registry, Ferguson (J. Bone & Joint Surg. **22:** 92, January 1940) observes that the number of five-year survivals was greater in that group where amputation was performed four to six months rather than one or two months after the onset of the disease. It is of interest that many patients in the first group received preoperative irradiation. The primary bone tumors most responsive to roentgen therapy are myeloma, reticuloendothelial sarcoma, and Ewing's sarcoma. In Ewing's tumor, the best results are obtained by preoperative therapy followed by amputation in several weeks.

Four case histories—one of solitary plasma-cell

myeloma, two of Ewing's sarcoma, and one of reticuloendothelial sarcoma—are presented, with roentgenographic reproductions.

LESTER M. J. FREEDMAN, M.D.

Osteogenic Sarcoma: I. A Modified Nomenclature and a Review of 118 Five Year Cures. Ian Macdonald and John W. Budd. Surg., Gynec. & Obst. **77:** 413–421, October 1943.

This article is based on an analysis of the five-year cures of "osteogenic sarcoma" among the cases registered by the Registry of Bone Sarcoma of the American College of Surgeons. In 1941 there were 1,022 registered cases of osteogenic sarcoma, of which 654 had been treated five years or more prior to 1941. Of this group only 97 (14.8 per cent) were accepted as five-year cures. In the material were found, also, 115 cases of chondrosarcoma with 21 five-year cures. The histories, roentgenograms, and microscopic slides of the cured group were studied, and 47 fatal cases were similarly reviewed.

Of the cured cases 31 per cent were characterized by a spindle-cell morphology with a fibroblastic type of stroma, 46 per cent belonged to the chondroma series, and only 12 per cent were true bone-producing sarcomas. Four cases showed sufficient differentiation to justify a compound name, and 6 cases were regarded as not properly belonging in this series.

For the bone-producing tumors the name "osteosarcoma," a term formerly employed by Mallory, Ewing, and others, is recommended. It is further recommended that the classification of the Bone Sarcoma Registry be modified to include under the Osteogenic Series the following: (*a*) osteosarcoma, (*b*) chondrosarcoma, (*c*) fibrosarcoma, and that the term "osteogenic sarcoma" be used as a generic designation for the triad of connective-tissue sarcomas primary in bone.

The analysis of cured and uncured cases indicated that true osteosarcoma is almost uniformly fatal, while fibrosarcoma is distinctly less malignant. Chondrosarcoma seemed to occupy a median position. Encapsulation of osteogenic sarcoma is a favorable prognostic element, while the amount of matrix was not proved to be of significance in this respect.

Natural selection determined curability to a greater degree than did early treatment, for the delay in radical treatment was greater in the cured than in the uncured neoplasms that were studied. Biopsies were performed with more frequency in the cured than in the fatal cases. The value of irradiation as a complementary curative agent in osteogenic sarcoma could not be demonstrated in the data that were studied, but the authors do not deny the importance of radiotherapy as a palliative measure in many cases. JOHN O. LAFFERTY, M.D.

Hemangioma of Vertebra with Compression of Cord: Report of a Case Cured with Radiation Fourteen Years Ago. L. Minor Blackford. J.A.M.A. **123:** 144–146, Sept. 18, 1943.

A review of the literature disclosed reports on 65 cases of hemangioma of the vertebrae associated with compression of the spinal cord. In 13 of 14 cases irradiated, excellent results were obtained. The author reports an additional case in which irradiation caused regression of a vascular tumor presenting posteriorly over the right half of the eleventh thoracic vertebra, with complete disappearance of all signs of spinal cord compression. Fourteen years after treatment the patient was normal clinically. Roentgenograms of the spine made prior to irradiation failed to demonstrate the characteristic striated appearance of hemangioma in bone or any evidence of osseous destruction.

DEPARTMENT OF ROENTGENOLOGY
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Consideration of the Response of Bladder Tumors to External Radiation. Charles C. Herger and Hans R. Sauer. J. Urol. **50:** 310–321, September 1943.

The response of bladder tumors to external radiation depends on a variety of factors, including the radiosensitivity of the tumor, the technic of irradiation, histology, size and extension of the tumor, kind and degree of infection, kidney function, and the general condition of the patient. Papillary carcinomas of the bladder are an exception to the general rule that the response of highly differentiated tumors to irradiation is poor.

Tumors are classified, according to Warren's suggestion, as radiosensitive tumors, responding favorably to less than 2,500 r; radioresponsive tumors, requiring between 2,501 and 5,000 r; radioresistant tumors, requiring more than 5,000 r to obtain a favorable response.

The authors treated 160 patients with bladder carcinoma in a four-year period beginning Jan. 1, 1938, giving external irradiation before any other kind of therapy was employed. Of these, 15.6 per cent had papillary carcinoma, 56.9 per cent papillary infiltrating carcinoma, and 27.5 per cent solid infiltrating carcinoma. More than half of the papillary growths were multiple, while this was true of only 10 per cent of the solid infiltrating tumors. Irradiation was given (1) in patients with multiple papillary growths of low-grade malignancy; (2) in patients with very large single papillary tumors or large solid infiltrating carcinomas which were not considered suitable for surgical attack at the time of admission; (3) to control hematuria due to bleeding from tumors in which electrocoagulation failed. Small single papillary carcinomas were treated with electrocoagulation and radon. Small solid infiltrating tumors received interstitial irradiation. Kilovoltages of 200, 400, and 1,000 were employed. With 200 kv. two to four portals were treated with a daily dose varying from 100 to 400 r.

Satisfactory results from irradiation were obtained in more than 50 per cent of the patients with papillary and papillary infiltrating carcinoma. In 13 of these cases the tumor disappeared entirely after external irradiation alone. In 44 patients, marked regression in size and number of the tumors was obtained, thus rendering the tumor susceptible to subsequent electrocoagulation, radon seed implantation, or both. In 24 patients, regression was only temporary. No response was obtained in 35 patients.

Of the 44 solid infiltrating carcinomas, only one responded favorably to roentgen therapy. Interstitial radon or surgery is recommended for these cases.

DAVID KIRSH, M.D.

Multiple Carcinoma. Clinical Picture, Diagnosis and Prognosis. Hugo Hellendall. Am. J. Surg. **60:** 22–35, April 1943.

The clinical picture and diagnosis of multiple primary carcinoma, based upon 30 examples observed among 685 cancer autopsies at Presbyterian Hospital, New York, are discussed. In 21 cases the cancers were synchronous (occurring simultaneously); in 9 instances

metachronous, the second originating after operation for the first. In 24 of the 30 cases the digestive tract was the site of one of the tumors and in 11 the multiple cancers arose exclusively in the digestive tract.

Two or more primary cancers originating in different parts of the same organic system or in different organic systems will obviously produce very different effects than cancers occurring in the same organ. The formation of metastases, complications caused by the cancer, and independent diseases may change and influence the clinical picture. Analysis of the 30 cases observed brought out the fact that the period from the first appearance of symptoms until death was shorter in cases of multiple primary malignant growths than in single ones; the weight loss was also considerably greater. In 5 metachronous cases of multiple cancer, the duration of life was greater than in 5 corresponding synchronous cases. In 3 of the metachronous cases, the loss of weight was less than in corresponding synchronous cases.

The correct diagnosis of multiple cancer was made during life in 4 of the synchronous and in 5 of the metachronous cases of multiple cancer. The importance of a complete x-ray examination of the entire gastrointestinal tract is stressed. In several of the cases studied large gastric or duodenal tumors went unrecognized in the absence of x-ray studies.

Thirteen clinically observed cases of multiple cancer were also studied. Two patients with multiple synchronous cancers and three patients with cancers of the metachronous type were still living at the time of this report, but none was alive as long as five years after operation.

NON-NEOPLASTIC DISEASE

Minor Roentgen Therapy. Sydney J. Hawley. Pennsylvania M. J. **46:** 1278–1281, September 1943.

There is a tendency on the part of the general practitioner, and to some extent the radiologist, to forget that many non-cancerous ailments may be effectively treated by irradiation. Some of the more common conditions and technics are enumerated.

Lymphoid hyperplasia in the pharynx, usually seen in children, less commonly in adults, causes deafness because of occlusion of the eustachian tubes. Such cases may be treated by 600 to 800 tissue r given in four to six applications over each side of the pharynx (200 kv. with 0.5 mm. Cu filter). About 20 per cent of cases require a second series in six months.

For *tuberculous cervical adenitis*, 100 to 200 tissue r are given once or twice a week for a total of 800 to 1,000 r. The voltage may vary from 100 to 200 kv. with from 0.5 to 1.0 mm. Cu. Resolution of the tuberculous lesions takes place in six to eight weeks. *Nonspecific cervical adenitis*, which frequently is caused by tonsillar or dental infection, is treated with 100 tissue r on two successive days. Not more than four treatments should be given.

Carbuncles and abscesses are given 100 tissue r a day for not more than four treatments. *Furunculosis* is usually relieved by 100 tissue r every other day for six to eight treatments.

Patients suffering with *pertussis* are given 100 tissue r over the mediastinum through two portals, posteroanterior and anteroposterior, every other day for four treatments (200 kv., 0.5 mm. Cu). This treatment is not a specific but does decrease the cough.

Hyperhidrosis may be controlled by 100 tissue r at low voltage applied to the front and back of the hands and feet twice a week for three weeks.

Verrucae may be divided into four classes: (1) Warts of adolescence should not be treated, as they disappear spontaneously in a few months. (2) Warts at the edge of the nail should be well masked with lead and 2,500 r, measured in air, given at one sitting. The treatment is difficult by any method and in about half the cases recurrences are to be expected. (3) Plantar warts and (4) common warts not included in the other classes are treated by 1,500 r at one sitting, with low voltage.

Corns and calluses are treated by 1,000 to 2,000 r (low voltage) measured in air at one sitting, the adjacent skin being protected. One treatment is sufficient, but there will be a recurrence if the cause of the lesion—namely, tight or ill-fitting shoes—is not removed.

Keloids and hypertrophic scars are given 800 to 1,200 r in air (low voltage) at one sitting. This may be repeated once if regression does not occur.

JOSEPH T. DANZER, M.D.

Roentgen Therapy of Laryngeal Tuberculosis. Clarence W. Engler. Ann. Otol., Rhin. & Laryng. **52:** 655–665, September 1943.

It is universally agreed that laryngeal tuberculosis is practically always secondary to pulmonary tuberculosis. Important factors in the healing process are the nature and extent of the pulmonary disease, a good general resistance on the part of the patient, and maintenance of body weight and appetite.

For the sake of simplicity the author uses the classification of Rickmann, who recognizes the following types:

1. "The productive or proliferative type. In this the lesion is fairly well defined and localized. Usually some degree of organization with a tendency toward healing is present.

2. "The exudative type. The lesions in this type are diffuse so that several structures, such as the vocal cords, the epiglottis, and the arytenoid areas, may be the seat of the disease at the same time.

3. "The mixed type. In this type both productive and exudative lesions exist in the same larynx. In all three types, infiltration and ulceration may be present."

There is no unanimity of opinion regarding the type of laryngeal lesion that will be improved by irradiation. It is the consensus that fractional doses give the best results and are safer than large doses, inasmuch as the dangers of cartilage necrosis and glottic edema are greatly lessened. After irradiation, sufficient regression may take place so that a previously hidden ulcer may come to view.

For the present series the physical factors employed consisted of 200 kv. potential; 0.75 mm. Cu plus 2.0 mm. Al filtration (H.V.L. of 0.9 mm. Cu); 50 cm. target-skin distance. Originally a dose of 100 r was administered to each side of the neck every ten days for ten treatments. Later the procedure was changed and only one side of the neck was irradiated with 150 r (measured in air) every ten days, the sides being alternated for a period of 200 days, or a total dosage of 1,500 r (150 r × 10) to each side. With a 20-ma. current, the output delivered was 35 r per minute. There was no instance in this series of radiodermatitis and no patient exhibited skin erythema.

The cases receiving roentgen therapy were not

selected discriminately. In all, 38 patients were treated; some had the productive type, others the exudative, and a few the mixed type of tuberculosis. Healing of the larynx was secured in 8 cases, or 21 per cent; 6 cases, or 16 per cent, showed improvement in the condition of the larynx; in 8 cases, or 21 per cent, the laryngeal picture remained unchanged; in 16 cases, or 42 per cent, the disease became definitely worse.

Five of the 8 patients showing no change were treated with electrocautery either before or after the roentgen therapy was given. In none of them was any improvement obtained. All but one of these cases were of the exudative type.

The largest group of patients was that in which the condition became worse. In most of these, the pulmonary disease was of the active, progressive type, as confirmed by the fact that 12 of these patients died.

The laryngeal lesion may heal while the pulmonary disease progresses. In 3 of the 8 patients with healing of the larynx the lung condition became worse and of 6 with improvement of the laryngeal lesion 4 showed progression of the pulmonary disease. In a few cases the lung condition improved while the laryngeal lesion remained unimproved or progressed unfavorably.

From the material available one cannot determine the exact type of lesion that will be benefited by roentgen therapy nor can one say that it is superior to other local measures, such as electrocauterization.

STEPHEN N. TAGER, M.D.

Some Observations on the X-Ray Treatment of Ankylosing Spondylitis. Gwen Hilton. Proc. Roy. Soc. Med. **36:** 608–610, September 1943.

The author reports the use of x-ray therapy for ankylosing spondylitis in 62 patients during the past three years. Roentgen classification according to location and extent of changes was discarded, since there was little relationship between the roentgen findings and the severity of the disease. In addition, the bony changes appear irreversible, so that x-ray re-examinations give no criteria of results from therapy. The series was therefore classified as to duration of symptoms.

The course of therapy to the sacro-iliac joints and vertebral column consisted of 18 treatments, but no details as to factors or dosage are given except that small "local" applications were used rather than the wide field or "bath" technic.

In the assessment of results only 47 patients treated more than six months before the time of the report are considered. Complete relief from pain was obtained in 7 patients and partial relief in 38 patients. As pain diminished, usually two weeks following the last treatment, movements of the spine became more free. In several cases, the course was repeated in six to eight months. The sedimentation rate usually became increased for some months despite symptomatic improvement. Best results were obtained when physiotherapy was combined with x-ray therapy.

LESTER M. J. FREEDMAN, M.D.

Treatment of Cold Abscesses by Combined Surgical Drainage and Roentgen Therapy. Alfredo Pavlovsky. Radiologia **6:** 7–11, January–April 1943.

The author advises combined surgical drainage and roentgen irradiation for the treatment of cold abscesses. After surgical incision or emptying the abscess with the aid of a trocar and cannula, the cavity, when possible, is packed with iodoform gauze and pockets are destroyed. The following factors are advised for roentgen therapy: 200 kv., 4 ma., 40 cm. distance, 1.5 mm. Cu plus 1.0 mm. Al filtration. For younger patients, those below thirteen years of age, the technic is modified as follows: 160 kv., 3 ma., 25 cm. distance, 0.2 mm. Cu plus 5.0 mm. Al filtration. The patient is given 200 r every other day for three doses, the treatment to be repeated in one month and, if found necessary, after another month.

Illustrative cases are presented. The author believes his results to be good. A. MAYORAL, M.D.

Roentgen Therapy in Ano-Vulvar Pruritus. José Luis Molinari and Anibal Lemos Ibáñez. Radiologia **6:** 19–21, January–April, 1943.

Although many gynecologists, internists, and surgeons condemn the method, the authors believe roentgen therapy to be of value in the treatment of ano-vulvar pruritus. They report excellent results in a review of 205 cases. The factors used are as follows: 100 kv., 4 ma., 25 to 50 cm. distance, 1.0 mm. Al filtration. Weekly doses of 200 r are given for 5 weeks. Sometimes smaller doses—400 to 600 r—have been sufficient to control the itching. In cases in which no relief is obtained, further treatment may be given after a three-month interval. A. MAYORAL, M.D.

Radio-Phosphorus. An Agent for the Satisfactory Treatment of Polycythemia and Its Associated Manifestations; Report of a Case of Polycythemia Secondary Possibly to the Banti's Syndrome. Lowell A. Erf and Harold W. Jones. Ann. Int. Med. **19:** 587–601, October 1943.

Polycythemia is a disease of unknown etiology characterized by a chronic course and a considerable increase in total blood volume over the normal, with an absolute increase in the total number of red blood cells and often of white blood cells and platelets.

A previous paper (Ann. Int. Med. **15**: 276, 1941. Abst. in Radiology **39**: 645, 1942) reported marked clinical and hematological improvement in 6 cases of polycythemia following administration of radiophosphorus. Those 6 patients have been maintained in essentially complete clinical and hematological remissions for nearly two years. Eleven additional cases are now recorded.

All of the radioactive phosphorus solutions were injected intravenously. In the majority of cases the total dosage was between 7 and 11 millicuries. The first significant hematological responses occurred about 60 to 100 days after the first injection.

Of the 11 patients, 6 were white males (2 Russian Hebrews), 4 were white females, and 1 was a colored female. Each patient had had polycythemia from two to eight years before therapy with radiophosphorus was instituted, and all had received many types of therapy, such as roentgen irradiation, ultraviolet irradiation to skin or to auto-transfused blood, Fowler's solution, phenylhydrazine, venesection, etc., but in none did satisfactory remissions follow such treatments. None had been treated with lead compounds or spray roentgen therapy. The symptoms varied widely: some were cerebral or spinal in character, such as lethargy, dizziness, staggering (multiple sclerosis syndrome), and incontinence; some were referable to the gastro-intes-

tinal tract (symptoms of duodenal and stomach ulcers, gastric bleeding); others to the vascular system (tender congested toes, thromboses, varicosities, prolonged bleeding tendencies), the cutaneous system (eczema, acne urticata, indolent leg ulcers), the osseous system (arthritis), the urinary system (bloody urine), and the reticulo-endothelial system (splenic infarcts).

The clinical and hematological findings in the 11 cases before and after administration of radiophosphorus are presented in comprehensive tabular form. Sternal marrow studies were made in 8 patients before and in 8 after treatment, and these also are tabulated.

After treatment with radiophosphorus, the patients usually showed a gain in weight, good appetite, and clinical and hematologic remission. The coagulation time of polycythemic blood is abnormally prolonged, and patients bleed readily following minor cuts. This symptom also disappeared. The authors suggest that the mechanism of the radiophosphorus effect may be similar to that of "spray" roentgen therapy, which is said to produce excellent remissions. Radiophosphorus is concentrated in the bone marrow, continuously bombarding this for days. Both radiophosphorus and roentgen radiation probably decrease red cell production by retarding mitosis of normoblasts in early prophase. In both types of treatment the period of irradiation (by beta particles) is prolonged, which may be an effective factor.

A full history of a case in which the microscopic findings were suggestive of Banti's disease is appended.

EFFECTS OF RADIATION

Metabolic Changes Occurring as the Result of Deep Roentgen Therapy: I. Effect of 200 Kilovolt Roentgen Therapy. Douglas Goldman. Am. J. Roentgenol. **50:** 381–391, September 1943.

The investigation described here was undertaken with the idea of determining what changes in the body economy result from deep roentgen therapy (200 kv.), especially in relation to the symptom complex known as "irradiation sickness" and in relation to the wave length of radiations. The patients observed were on constant, accurately weighed diets, potentially neutral, low in purines and calcium, and in most instances minimal in chloride. Analyses of urine, feces, and vomitus, if any, were made for inorganic constituents. Nitrogen, uric acid, and other components of the nitrogen partition were determined on the urine only.

Changes in the excretion of total nitrogen and its components are the most definite deviations from the control values presented by the investigations. There was, in general, an increase in the urinary output of total nitrogen either during the periods when radiation was being given or immediately following cessation of the treatment. Nitrogen loss was greater in patients with radiosensitive tumors. Both uric acid and, to a lesser degree, ammonia were found to be involved in this nitrogen increase. The total acid of the urine was definitely higher in most cases during or after roentgen therapy, probably the result of greater destruction of body protein. A slight diminution in amino-acid nitrogen excretion took place two to six days after irradiation and continued to the end of the observations. This seems to indicate a storage of nitrogen after the primary destructive effect of irradiation had worn off.

No significant deviation of the calcium balance from control values was observed. Increase in the urinary phosphorus output was found during or following roentgen therapy with deviation of the balance to the negative side. A small but definite increase in the urinary sulfur and sulfate occurred following irradiation. All of the patients who became severely ill showed a definite chloride loss during the irradiation period. The chloride balance became positive shortly before or simultaneously with improvement in symptoms. Sodium chloride by mouth is very frequently an effective therapeutic agent in irradiation sickness. In some cases its action was dramatic. There is a definite susceptibility to roentgen sickness of patients with protracted sodium chloride starvation.

CLARENCE E. WEAVER, M.D.

Metabolic Changes Occurring as the Result of Deep Roentgen Therapy: II. Effect of 1,000 Kilovolt Roentgen Therapy. James E. Robertson. Am. J. Roentgenol. **50:** 392–399, September 1943.

Seven patients were subjected to a careful study of nitrogen and chloride metabolism before, during, and after 1,000-kv. roentgen therapy. The results proved to be similar to the results of the study conducted in the same laboratories on the effect of 200-kv. roentgen therapy (see preceding abstract). Supervoltage roentgen radiation was shown to produce an increased excretion of nitrogen, uric acid, and chloride in some of the patients, just as does radiation of lower voltage. That the negative nitrogen balance results entirely from tissue destruction is strongly indicated by its restriction to cases in which large tumors disappear under the influence of roentgen radiation. In all cases in which study was sufficiently prolonged, a period of nitrogen storage followed that of nitrogen loss.

Chloride metabolism changes in the nature of a negative chloride balance were demonstrated, but less frequently in the patients receiving the 1,000- than the 200-kv. therapy. Though the chloride change seems to be correlated with the degree of nausea and vomiting, this study suggests that it is a secondary result of a disturbance in water balance rather than the precipitating cause of the roentgen sickness. Roentgen sickness was observed much less frequently under million-volt roentgen therapy than under 200,000-volt roentgen therapy. No significant differences in changes in metabolism induced by irradiation with 200-kv. and 1,000-kv. roentgen rays were demonstrated.

CLARENCE E. WEAVER, M.D.

Radiodermatitis of the Head and Neck with a Discussion of Its Surgical Treatment. F. A. Figi, G. B. New, and C. R. Dix. Surg., Gynec. & Obst. **77:** 284–294, September 1943.

Serious damage to the skin may follow the use of radium or roentgen rays even when relatively small dosage is given, but the hazards of such treatment are well known, and prophylactic measures are reducing the incidence of such lesions. The total dosage and factors of application are chiefly responsible for the tissue reactions, but exposure to sunlight or other rays, and chronic irritation of various sorts, combined with the inherent sensitivity of the skin itself, play a part in the production of irradiation dermatitis. Numerous extensive lesions have followed use of roentgen rays by beauty shop operators for depilatory purposes. Other cases have followed repeated appli-

cations of roentgen rays or radium to angiomas of the "port wine" type, which are notoriously radioresistant. Among physicians, dentists, and technicians, who constantly use radiation, lack of proper appreciation of the dangers involved, and perhaps lack of proper protection, has led to serious skin injury. In spite of the danger to both patient and administrator, the results obtained well justify this form of treatment.

Radiodermatitis may be acute or chronic, mild or severe. The acute form is comparable to the three stages of ordinary burns, except that healing progresses much more slowly. A dusky blue erythema is noted at the end of two weeks, and either dry or exudative dermatitis at the end of three weeks, often followed by increased pigmentation and loss of hair, and rarely by final loss of all pigment. The destructive effect of irradiation is greatest in a central area, decreasing gradually toward the periphery of the exposed field, leaving at times no clear line of demarcation between devitalized and healthy tissues. Necrosis, sloughing, and secondary infection may occur, which require weeks or months for healing, with the ever present danger of another breakdown of the central area months or even years later. Except in the mildest reactions, some secondary skin changes are certain to appear, occasionally after a lapse of years.

The chronic form follows the acute reaction after a latent period of one to ten years, during which there may be no visible skin changes. Occasionally the chronic form may be produced by repeated small exposures. In this stage marked skin changes take place, with dryness, fissuring, telangiectasia and atrophy of the surface, with loss of glands and hair follicles, so that the skin assumes a smooth, dry, glistening appearance. Keratoses, sclerosis, and induration develop later, and the skin becomes thick, leathery, and immobile. Skin atrophy and vascular obliteration lead to necrosis and sloughing, and deep ulcers may form, with thick, indurated edges and a necrotic base fixed to the underlying structures. In the region of the head and neck perforation into the mouth, nose, larynx, or trachea may occur. The ulcerations are extremely indolent and show little or no tendency to heal. Secondary infection takes place, with pocketing of purulent material. Intense itching and intractable pain are additional unpleasant complications.

Malignant changes, usually epitheliomas of the squamous-cell type, may develop in the keratoses and persistent ulcers after a latent period of months or years. The incidence of malignant changes in the groups mentioned by the authors varied from 10 to 19 per cent. The malignant activity of these lesions is usually moderate or of low grade, but fulminating types may appear. The large amount of sclerosis present in these lesions retards the occurrence of metastases, and treatment carried out promptly after the appearance of the malignant process offers a satisfactory prognosis.

Because of the sclerosis and ulceration, contractures may be present, but because keloids are absent, they occur less commonly than in burns from either heat or caustics. Located near the eyelids, lips or nostrils, contractures may constitute the most serious factor of the condition.

The pathological tissue changes in radiodermatitis produced by either roentgen rays or radium are (1) destruction of hair follicles, sweat and sebaceous glands; (2) replacement of normal collagen by a dense hyaline collagen rich in elastic and cellular tissue; (3) obliteration of the smaller blood vessels in the corium and subcutaneous tissue, and thickening of the walls of the larger vessels; (4) necrosis and rarefaction of the corium with thrombosed areas of telangiectasia; (5) reparative proliferation and hypertrophy of the epidermis.

Unless damage to the tissues has been unusually severe, the acute reaction is self-limited and runs its course of weeks or months regardless of the treatment given. Soothing ointments, drying lotions, sulfathiazole powder, solutions of acriflavine and gentian violet, or warm moist compresses may palliate the condition and combat the infection and acute inflammation. Radical measures are contraindicated at this time because of the sloughing and infection; they tend to aggravate the condition and prolong healing.

The treatment of chronic radiodermatitis depends on the extent and severity of the damage, the presence of malignant change, and the age and general condition of the patient. When sclerosis, atrophy, and hyperkeratoses are pronounced, with ulcerations, only surgical treatment is likely to afford relief. If the lesion has undergone malignant change, surgery is imperative. This consists of removal of the diseased tissues and repair of the resultant defect. In the presence of infection, necrosis, or extensive malignant changes, it is preferable to leave the wound open and defer repair until a later date. Examination of frozen sections may warrant immediate plastic repair in many suspected cases. Whether the wound is left open or not, excision of the process usually affords immediate relief of the distressing symptoms, relaxes contractures if present, offers immediate opportunity for histological study, and prepares a graft bed with a greatly improved blood supply. Excision must extend well beyond the region of marked tissue change even at the expense of relatively important structures. Because of the extremely slow rate of sequestrum formation in irradiation necrosis, affected bone should be removed well into freely bleeding territory. Soft-tissue excision need not extend beyond the region of sclerosis and telangiectasia. Use of the electrocoagulation scalpel is recommended because of the easier control of vascular oozing and because a graft will usually take readily on a surface so prepared.

The method of repair depends on the location and extent of the lesion and the malignant changes present. Removal with simple primary suturing of the undercut edges may be possible. Multiple partial excisions, with intervening periods for healing and relaxation of the tissues, if feasible, permit wide removal without distortion and only linear scarring. Wide involvement about fixed points, such as the nose and ears, usually requires free skin grafts or pedicle flaps. In these cases, if superficial ulceration and considerable inflammatory reaction are present, it may be advisable to apply thin shaved grafts; after these have healed and the inflammation has disappeared, full-thickness skin grafts or pedicle flaps may be used to recover the surface. Full-thickness skin grafts contract little, are more resistant to trauma, and present a better cosmetic appearance than thin grafts. They should not be used in the presence of infection nor in areas which cannot be protected from contamination or which cannot be immobilized. With deep involvement some type of pedicle flap is indicated, which is usually prepared in advance of the excision and transferred to the fresh wound only when ready for it. Tubed pedicle flaps are

often desirable in cases of extensive radiodermatitis about the lower face or neck.

The authors state that surgical treatment of radiodermatitis is highly satisfactory as regards relief of symptoms, correction of deformities, and restoration of function. Surgical removal of neoplasms developing in areas of irradiation dermatitis, because of their slow rate of metastasis, offers an excellent chance of cure if done at a reasonably early stage.

DEWAYNE TOWNSEND, M.D.

EXPERIMENTAL STUDIES

Effects of Roentgen Rays on Cell-Virus Associations. Findings with Virus-Induced Rabbit Papillomas and Fibromas. Wm. F. Friedewald and Rubert S. Anderson. J. Exper. Med. **78:** 285–303, October 1943.

Experiments reported in detail by the authors were undertaken (1) to study the possible quantitative changes in the amount of virus associated with living papilloma cells under the effect of x-ray irradiation; (2) to determine whether a variant of the virus could be produced by irradiation. The viruses causing the papillomas of domestic and cottontail rabbits, and also the infectious fibromatosis of rabbits, were subjected to comparable experiments.

The virus-induced papillomas of cottontail and domestic rabbits regress completely within a few weeks when exposed to 5,000 r of x-ray radiation. The associated virus persists in undiminished amounts during regression and often an increased yield can be obtained on extraction. The increased yield suggests several possibilities.

1. The cells are so altered by x-ray as to favor rapid multiplication of the virus. Against this are the observations: (*a*) that an increased yield of virus was found in papillomas removed within an hour after irradiation; (*b*) that the papilloma virus is extremely resistant, retaining its activity well in keratinized tissue, yet no increase in the amount of it was found when the growths had been removed several days after irradiation.

2. X-rays cause a temporary change in virus-cell relationship such that more virus comes away on extraction—a possibility that is more likely.

The fibroma virus in crude extracts or *in vivo* is inactivated by far less radiation than the papilloma virus. Ten thousand r destroy 90 per cent or more of the infectivity of the fibroma virus, whereas at least 100,000 r are required to inactivate 50 per cent of the papilloma virus in extracts containing about the same amount of protein. The greater sensitivity of the fibroma virus is possibly explained by particle size. The volume of the fibroma virus particle has been shown to be 25 to 50 times greater than the volume of the papilloma virus particle. Furthermore, extraneous protein reduces the indirect water reaction of x-rays.

No variant of the papilloma virus or fibroma virus has been encountered as a result of the irradiation.

SIDNEY LARSON, M.D.

Radioactive Phosphate as an Indicator of the Relationship Between the Phosphate Changes of Blood, Muscle and Liver, Following the Administration of Insulin. Nathan O. Kaplan and David M. Greenberg. Am. J. Physiol. **140:** 598–602, January 1944.

The changes in the phosphates of blood, muscle, and liver produced by insulin were studied by means of tracer experiments with radioactive phosphate.

Insulin caused an increase in the total acid soluble P^{32} of the liver and muscle; an increase in the total acid soluble P^{31} was noted only in the liver. The rate of disappearance of inorganic P^{32} from blood was accelerated by insulin.

Insulin induced a rise in the P^{31} and P^{32} of the barium-soluble fraction of blood, muscle, and liver. The specific activity of this fraction was increased in muscle and liver but not in blood. The rise in the barium-scluble fraction in the blood is believed probably to be due to an increased esterification of glucose. In the muscle the increase mainly represents newly synthesized hexose monophosphate. The barium-soluble fraction of the liver contains very little hexose monophosphate; the main component may be glycerol phosphate.

Evidence is presented which indicates that insulin produces similar effects in blood, muscle, and liver.

A Study with Radioactive Isotopes of the Permeability of the Blood-Cerebrospinal Fluid Barrier to Ions. David M. Greenberg, *et al.* Am. J. Physiol. **140:** 47–64, October 1943.

This paper reports another application of radioactive isotopes to the investigation of physiologic problems. The authors studied the permeability of the blood-cerebrospinal fluid barrier to ions and report their findings in considerable detail.

Elimination of Administered Zinc in Pancreatic Juice, Duodenal Juice, and Bile of the Dog as Measured by Its Active Isotope (Zn^{65}). M. Laurence Montgomery, G. E. Sheline, and I. L. Chaikoff. J. Exper. Med. **78:** 151–159, September 1943.

The authors, using dogs prepared with pancreatic, biliary and duodenal fistulae, measured by means of the Geiger counter the amount of radiozinc in the secretion after injecting intravenously zinc chloride containing Zn^{65}. Radiozinc appeared in the secretions of the pancreas within thirty minutes after intravenous injection of the labeled zinc. Radiozinc practically disappeared from the plasma in forty-eight hours, yet was excreted from the pancreas as long as fourteen days. A large proportion of injected radiozinc is eliminated by way of the external secretion of the pancreas—as much as 11 per cent in fourteen days.

Very little radiozinc appears in the bile, the maximum excretion being 0.4 per cent in eight days.

Radiozinc was found in large amounts in the duodenal juice from an isolated loop of duodenum. In view, however, of large amounts of the substance found in the sediment of duodenal juice, conclusions regarding the significance of duodenal secretions in the elimination of zinc should be withheld for the present.

The authors believe that pancreatic juice is a normal excretory pathway for zinc. The high concentration of radiozinc in the pancreatic juice, compared with the low concentrations in the plasma, indicates that the acinar cell concentrates zinc.

SIDNEY LARSON, M.D.

RADIOLOGIC SERVICES: GENERAL CONSIDERATIONS

The Future. Radiological Services. South African M. J. **17:** 327–329, Nov. 13, 1943.

The Radiological Society of South Africa distributed a questionnaire to 43 radiologists in the Union of South Africa and from 27 replies prepared a report on Radiological Services which it presented to the National Health Services Commission.

The recommendations for Diagnostic Radiology include the following:

Staff: Subject to war conditions, radiographs should be made by qualified radiographers (technicians) specially trained. They should not be permitted to do any x-ray screening (fluoroscopy) or to attempt diagnosis. In small hospitals and clinics, where no radiologist is available, simple interpretations may be made by general practitioners. Cases demanding detailed study should be referred to larger institutions where qualified radiologists are available. In large hospitals, a radiologist should be appointed on a full-time basis. Wide experience in large clinics should have more weight than degrees or diplomas.

Certain specialists, *e.g.*, those in urology, orthopedic surgery, cardiology, etc., may undertake film interpretation in their departments but close co-operation with the radiologist should always exist.

Research: Technical research may be left to the physicists, chemists, and engineers of the equipment manufacturers. Development of diagnostic methods is best produced by radiologists and other physicians.

Education: Instruction of the medical student should not be confined to a set number of lectures but should extend throughout his entire clinical training as the opportunity arises, under competent instructors. Postgraduate training for radiologists should be available. This has already been begun at the University of Cape Town in preparation for the Diploma of Radiology at that university.

Economics: "If private practice continues to play an important part in the medical services of this country for some time to come, it becomes necessary to examine the bearing which it will have on the organization of public (that is, national health services) x-ray diagnostic services." Large and medium-sized hospitals should have full-time radiologists, barred from receiving private fees. If part-time officials are appointed, they should be entitled to fees for work done on paying patients. The majority of the radiologists voted in favor of the percentage fee system, but it is felt that this may not be compatible with the desire of the medical profession that the hospital should make no profit on professional services, on the one hand, and not compete with private practitioners by charging lower fees, on the other. The system in use at the Groote Schuur Hospital (Cape Town), where the institution charges for technical service and the radiologist renders his fee directly to the patient, is suggested.

The following recommendations are made for Therapeutic Radiology:

General: No radiotherapy should be done in small hospitals or communities, with the exception of special skin clinics.

Staff: With the exception of dermatologists, radiotherapy should be practised by specifically trained radiologists alone. Qualifications should include personal character and energy, special knowledge of radiation physics and biology, wide clinical knowledge of medicine, surgery, gynecology and especially malignant tumors, and experience in or an aptitude for research.

Organization: Radiotherapeutic service should be arranged for treatment of certain conditions in medium-sized hospitals. The annual deaths from cancer among Europeans in the Union of South Africa and in Great Britain are about the same, namely, 14 per cent of all deaths. In Great Britain, the current assumption is 2,000 new cases per million population per year, of which 1,000 are suitable for treatment. On the basis of four weeks' hospitalization, the British Radium Commission recommends 75 beds for this number of cases. The required bed capacity for the Union of South Africa is estimated at 300 beds for Europeans and 300 beds for non-Europeans. Suggestions are given for distribution of these beds.

Research (Cancer) Institute: Unlike research in diagnosis, which is carried on as an integral part of other specialties, radiotherapeutic research is a special branch in its own right. A special institute devoted to the development of radiotherapy and the research required for its growth is essential. It is suggested that 60 of the 660 beds required for treatment be assigned to a state-aided Cancer Institute.

Education: Radiotherapy should be stressed to a greater degree in the medical schools.

Economics: Remuneration schedules should be similar to those for diagnostic radiologists. The centralization of treatment centers makes transportation problems a prime consideration. Hospital Social Service should be organized to issue transportation warrants for patients needing treatment, as well as for follow-up examinations. Other social and economic hardships could be alleviated by an efficient Social Service. LESTER M. J. FREEDMAN, M.D.